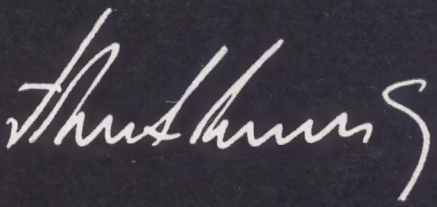
The science news monthly

SCIENCE DIGEST

MARCH 1966 50 CENTS ICD

The scientific promise of graphology and what it sees in

JFK's HANDWRITING



...ALSO JACKIE'S AND YOURS

PLUS: The material that will revolutionize construction

Secrets of how we think and learn

What jet travel studies teach us about fatigue

Goodbye to infection—biology's new promise

How to catch a galaxy

Sheep graze undisturbed on the plains next to Mills Cross radio telescope, Australia.

GALAXIES don't come our way every day. In fact, they dash through the skies away from us. One way to catch a galaxy, however, is to build a radio telescope.

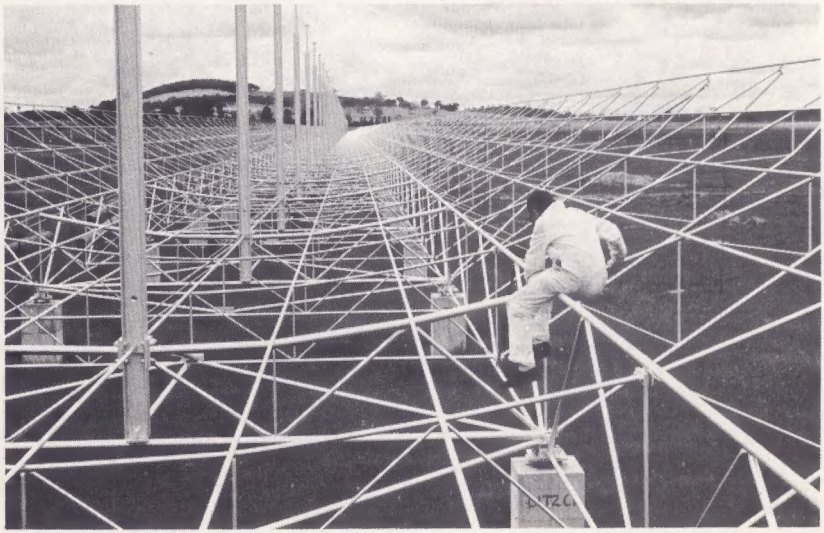
One of the largest radio telescopes in the world was just finished. The Miles Cross has two mile-long arms to aim toward the Milky Way from a site 30 miles from Canberra, Australia. When fully operational this year, it will be able to catch noises from as far away as the edge of the known universe.

The orderly array of 600 tons of steel framework and 22 acres of fine wire mesh, threaded to catch galatic noise, was designed by Professor Bernard Y. Mills. It is owned by the world's biggest radio astronomy and cosmic ray research center —the Cornell (University, N.Y.) Sydney (Australia) University Astronomy Center.

Mills Cross has a prime location to map the Milky Way radio emissions with a detail unknown until now. Its first big job will be to accurately survey and map the southern sky, a five-year joint project with Cornell's Arecibo, a big-dish radio telescope in Puerto Rico.

A technician clambers over a 42-foot-wide arm. Telescope arms are cylindrical parabolas of wire mesh, aiming a reflector to collect signals for an aerial system.

Photos by Australian News and Information Bureau



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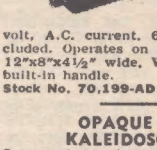

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THIS MONTH

BETWEEN six and seven thousand scientists converged on Berkeley, California, between Christmas and New Year's Days for the 132nd annual meeting of America's biggest scientific organization, the American Association for the Advancement of Science.

The scientists took over much of the huge Cal campus to deliver themselves of something like 2,000 papers on subjects ranging from weather modification to vertebrate morphology. Many of the subjects have already been covered by *Science Digest* in past issues. Many were significant, at least for the present, mainly to specialists seeking new information pertaining to their own research. Our task was to sift out new developments that portended important departures and had the widest interest.

Two of the "hottest" developments are reported in this issue, in *A Science Is Born: The Psychology Story* and *Yes, There Are Canals: The Astronomy Story.* Another paper, delivered by Harold C. Urey, helps answer a question, in *Please Explain,* about the possibility of life on extraterrestrial bodies.

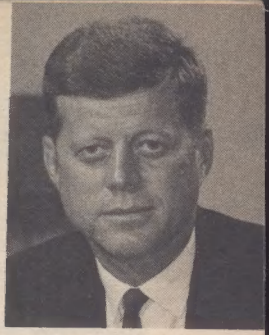
Other papers suggested a more rounded, detailed approach in articles in the months to come.

As our readers have come to expect, if it's science and it's news, they'll see it in *Science Digest.*

—THE EDITORS

SCIENCE DIGEST

The science news monthly



Handwriting can be an inside track to the personality of the writer, contends a graphologist. For his analysis of John F. Kennedy and an explanation of the scientific aspects, turn to page 55.

KFS photo

MARCH • 1966 VOL. 59, NO. 3

SCIENCE THIS MONTH

SCIENCE PANORAMA

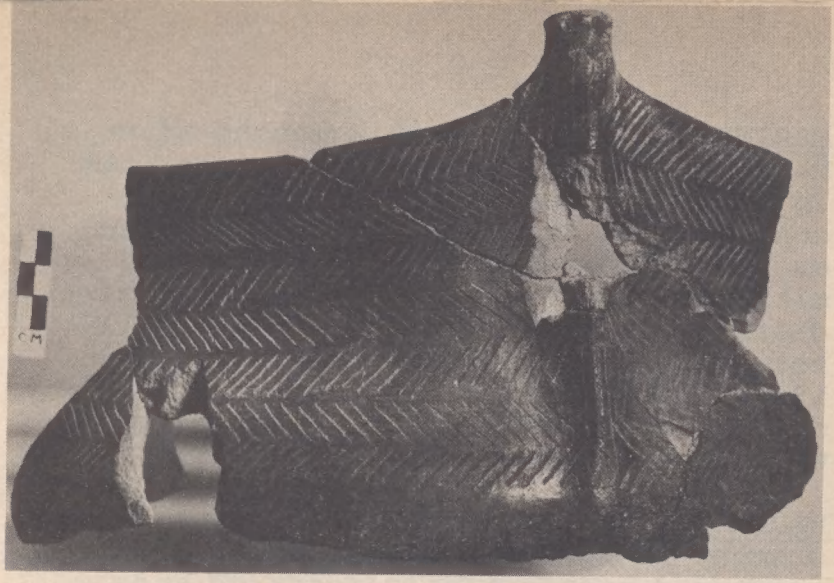
SCIENCE MISCELLANY

THE LATE SCIENCE NEWS

CATALOGUE OF THE UNIVERSE. A monumental new survey of radio sources in the sky by Cambridge University in England added still another piece of evidence to support the "Big Bang" theory, that the universe was born in a primordial explosion. The survey indicates the bright, powerful objects known as quasars were more numberous when the universe was young than they are today (see Did the Universe Ever Begin?, Aug.'65). In fact so many of these distant and ancient objects were found that they can not be explained by the concept of the expanding universe alone. Some astronomers believe that the large number of quasars mark the beginning of the violent processes of the birth of the first galaxies. The survey was discussed at a conference on cosmology held in Miami Beach during the last week of 1965.

FIRST FLASH. The astronomers at Miami also heard reports confirming an earlier discovery of what was taken to be the remains of the explosion that occurred when the universe was born. Five independent groups have identified microwave emissions that could be the remains of this first flash.

TURBULENT JUPITER. New observations showed that the planet Jupiter is much warmer than it should be if it were an ordinary planet. Jupiter is manufacturing its own heat, though no one knows how. University of Arizona Astronomer Gerard Kuiper likens the giant planet to "a small star."



MADE IN JAPAN. Ancient pieces of pottery dug up in Ecuador (like those shown above) may indicate that people from Japan came to the New World in 3000 B.C. or before. According to two Smithsonian Institution anthropologists the types of pottery found in Ecuador are too similar to types used in Japan to **signify** that the parallel is accidental. The scientists speculate that Japanese fisherman may have been blown off course and then carried by the prevailing ocean currents in an 8,000-mile arc across the Pacific to the coast of South America. The discovery raises the possibility of other ancient contacts between the Orient and the New World.

GLASS PUZZLE. A huge 8.8 ton-slab of glass was made at Beth She'arim, near modern Haifa, Israel, 1,400 years ago. Archaeologists who found it can't explain why it was made. The slab is an amazing technical feat and only two larger pieces were ever made, both in the 20th century.

MARINER SIGNALS. Over six months after Mariner 4 photographed Mars, scientists in California were able to make radio contact with it. The contact was made on Jan. 4 when the spacecraft was 216 million miles from earth, the greatest distance it will reach before gradually returning to within 30 million miles in 1967. The Mariner signal was equal to one-billionth of one-trillionth of one watt, according to NASA officials.

FEDERAL OCEAN INSTITUTE. The Federal Government brought together some of its scattered oceanographic research and services under a new Institute for Oceanography. The Institute will be given two more modern research ships and will use computer techniques and possibly satellites. Says Dr. Harris Steward, the director: "We hope to fill the gap between basic research at the private oceanographic institutes and the people who are actually physically pounding on the doors now for environmental information about the oceans that can be put to immediate, practical use."

SOVIET SLEEP LEARNING. The Russians began conducting large-scale experiments with sleep learning. In one test, 1,000 residents of Dubna tried to learn English by radio in their sleep. Most U.S. psychologists do not believe that there is any evidence that a person can learn while deeply asleep. They believe definitive tests have shown a person absorbs less and less information as he progresses from wakefulness to deep sleep.

LUNG CANCER CLUE. Examination of the lungs of smokers and nonsmokers indicated that a radioactive material found in cigarette smoke finds its way into the lungs. Although researchers do not believe there is enough radioactivity to cause cancer they think it may contribute to starting the cancer process in some people.

TROPICAL DISEASE TREATMENT. A Swiss firm announced the development of a safe and easy drug treatment for one of the most widespread diseases in the world. The disease, schistosomiasis or bilharziasis, debilitates hundreds of millions of people in the tropics and subtropics. Previous therapy for the parasite-caused disease has been painful and risky.

MOST POTENT VENOM. Poison from the skin of a tiny South American tree frog has been found to be far more toxic than any other known venom, said a National Institutes of Health scientist. Rain forest Indians use the venom from the skin of the kokoi frog to poison blowgun arrows.

QUOTE OF THE MONTH: "The more positive eugenic approach of encouraging preferential reproduction of persons of superior genetic constitutions--through use of sperm banks and artificial insemination, for example--is fraught with the seemingly insuperable difficulty of determining who decides on genetic superiority. With dairy cattle it is easy; we favor maximum milk production per unit cost. But what do we want in man?"--U. of Chicago President GEORGE W. BEADLE.

THE ENGINEERING PICTURE

photos, Pictorial Parade

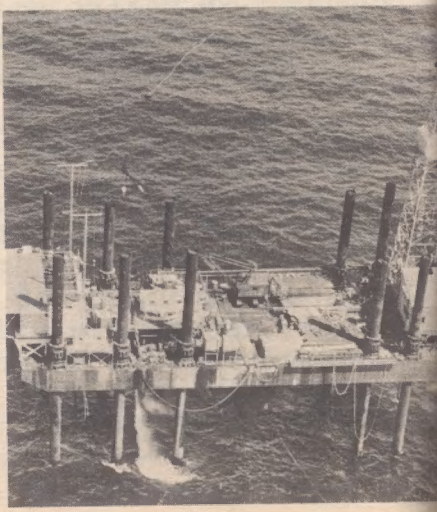
The stump of one of her legs, right, and one of her buoys are all that is left of "Sea Gem." A rescue craft stands by to aid survivors of the $7,000,000, 5,600-ton wreck.

Tragic sequel

A HUGE oil-drilling platform that could be floated from place to place in the North Sea was put into service this past fall by British Petroleum Exploration Company. The strange craft was pictured in the November, 1965, issue of *Science Digest*.

Late in December, the platform was being lowered on its ten legs until it was floating and could then raise the legs and be towed to a new location. At least two legs failed suddenly and, almost immediately, the whole structure collapsed and sank. The toll: 5 dead, 8 missing. Nineteen survived.

Sea-going oil platform looked like this in operation. It could operate in 100 feet of water and drill 10,000 feet down.



A science is born

An electric shock causes rats to respond with a stereotyped fighting posture time after time. Drugs are used to alter responses and reactions in a new biology.

by Hubert Pryor

A NEW science, as yet unnamed, made its formal bow a few days after Christmas. It had made sporadic appearances before, but it appeared in full bloom at the 132nd annual meeting of the American Association for the Advancement of Science in Berkeley, Calif.

Heading an impressive list of scientists reporting on this new field was Dr. David Krech of the Department of Psychology, University of California, Berkeley. The new science, he said, came from the "wedding of the science of animal behavior—psychology—and biochemistry."

"In my opinion," he declared, "this new science has within it as much explosive potentiality—in fact more—than the physical sciences."

The scientists reported on a wide range of experiments showing how chemicals can increase forgetfulness, sharpen memory, speed up learning and induce aggression.

Still other scientists investigating behavior reported on experiments in which electric shocks produced aggression, electrical signals boosted status and, conversely, *psychological* conditions created *physical* changes.

In all the experiments so far, animals have been used to study the interaction between physical and psychological forces. In one case, human applications are also being studied.

Evidence that memory is a chemical process involving the brain's manufacture of protein was reported by a University of Michigan professor of biological chemistry, Bernard W. Agranoff, M.D.

Dr. Agranoff and two assistants—a zoologist and a biochemist—divided a water tank into two compartments. Goldfish were placed in

one compartment and a light was turned on there. Twenty seconds later, an electric current was applied and the fish swam to the other compartment to avoid the shock. Then the process was repeated in the other compartment.

Their "memory scores" got better and better during 20 such trials, and they remembered their lesson days and months later.

But when an antibiotic drug known as puromycin was injected over their brains after 20 trials, the fish failed to remember what they had learned. That occurred when the drug was injected immediately after the 20 trials, which took 40 minutes. But if the injections were delayed an hour, there was no detectable effect on memory. The fish still fled from the light (in anticipation of the shock) four days later.

Puzzling mechanics

The mechanics of the process aren't fully understood, but a report accompanying the paper explained what went on in these words:

"Protein is normally formed from the amino acids in everyday diets or already in the body. A type of ribonucleic acid found in living cells, called transfer-RNA, is thought to act as a template or pattern for the molecule-by-molecule building up of complex proteins. But if puromycin is present, the forming proteins apparently combine with it instead of with the transfer-RNA and hence are released into the body's system before they can do their proper job."

Dr. Agranoff and assistant Paul Klinger inspect goldfish used in memory tests.

Experiments along the same lines, using rats, were conducted by Dr. N. P. Plotnikoff, a neuropharmacologist with Abbott Laboratories. But the chemical in this instance, magnesium pemoline, a mild central nervous system stimulant, had the opposite effect. Treated rats learned four to five times faster than untreated rats. Two scientists who worked with Dr. Plotnikoff reported that the chemical increases by two to three times the activity of the enzyme that makes RNA in brain cells.

Human trials of the drug are now under way.

Drugs that induce aggression were reported on by another Abbott scientist, Dr. Guy M. Everett. Mice given large doses of the common "pep pill" drug, amphetamine, he said, become so aggressive ."I have no doubt they would attack a cat if he stuck his paw in the cage."

Ordinary tranquilizers like Reserpine, he said, make the mice docile and disinterested.

Aggression has also been induced by electric shock. Dr. Roger Ulrich, professor of psychology at Western Michigan University, reported on the behavior of white rats placed in chambers with metal floors wired to produce a shock. They responded by fighting each other viciously. But there was an interesting twist:

Cooperative efforts

The rats were also separated by a plexiglass wall and trained to halt the shock when each rat pressed a different bar at the same time. As long as they were separated, they pressed the bars cooperatively. But when the partition was removed, they attacked each other.

Dr. Ulrich also reported on a corollary experiment that showed rewards can stop aggression just as pain can induce it. But leave out the rewards and you get aggression.

Dr. Ulrich trained pigeons to get a reward by pushing a button. When they didn't get the rewards, they turned vicious.

The lesson? Painful punishment, according to Dr. Ulrich, is futile in preventing hostile behavior. It may simply bring on more aggression.

Yale's Dr. Jose M. R. Delgado reported further on his experiments to alter behavior of animals by transmitting electrical signals to their brains by radio (see *Science Digest*, Aug., 1965). A man who has been able to make charging bulls stop dead in their tracks by this means, he worked this time with monkeys. One result, he reported, was to change the entire "pecking order" of the animals, by changing their aggressiveness.

The other side of the coin, how mental conditions can bring on physical reactions, was reported by Dr. Gordon T. Pryor of the Stanford Research Institute in Menlo Park, Calif.

In one study, rats were raised in solitude with unpleasant electric shocks and no chance to learn. Their brains became "musclebound" with measurable chemical and anatomical differences from other rats.

Other rats were raised in "enriched" environments, with social contacts and a pleasant atmosphere. They developed brains, Dr. Pryor reported, that were remarkably superior.

Similar experiments with rats by Dr. Edward L. Bennett of the Lawrence Radiation Laboratory in Berkeley produced animals with heavier cortexes, an increase in certain enzymes, heavier bodies and better able to solve problems.

Action of mind

What do all these reports mean?

An article in the AAAS journal, *Science*, six weeks before the association's meeting, announced the sessions at which they were to be presented. The article was entitled, "Are We Finding a Way to Study the Action of the Mind?"

After the Berkeley meeting, it's clear we've made an impressive start.

PERSONALITY OF THE MONTH

Bill Pickering, master scientist

Pickering's hallmarks are quiet, clear-cut analyses combined with executive skills.

by Andrew Hamilton

ONE OF these days, you'll be sitting at home watching TV, when a voice will say something like, "We take you now to the moon."

On the screen, an eerie lunar landscape will appear, shot by a camera placed on the moon's surface by a soft-landing Surveyor spacecraft.

Many people will have contributed to that achievement, but none more so than Dr. William Pickering of Pasadena, California.

Pickering is also one of the forces behind the United States' effort to put a man on the moon by 1970, to make soft landings on Mars and Venus—and to probe Jupiter.

"Every time an unmanned space rocket roars off the pad at Cape Kennedy," Pickering once said, "a little of my heart goes with it."

Fifty-five years old, 5 feet 10 inches tall, a slim 150 pounds, Pickering is director of the Jet Propulsion Laboratory which the California Institute of Technology operates for the National Aeronautics and Space Administration. He directs the activities of 4,200 scientists, engineers and technicians in a $100,000,000 laboratory that bulges with closely-guarded military and scientific space secrets.

But, as the *New York Times* pointed out about the laboratory, "Its single most valuable asset is the slight, shy, brilliant man who has been its director of more than a decade, Dr. William Hayward Pickering."

20-year link

Pickering joined the Jet Propulsion Laboratory—JPL for short—in 1944, when its chief function was to produce JATO units to help planes get off short runways. Ten years later, on Sept. 1, 1954, he moved into his present job as director. His tenure of office has spanned all the years of America's explo-

sively expanding space program.

Few people have ever seen Pickering ruffled. In 1957 when the Russian-launched Sputnik panicked many officials, Pickering called the confusion "a sorry spectacle." He deplored widespread "unwillingness to face up to the fact that the Russians are ahead of us." He pointed out that the need was not for flashy breakthroughs, but "strong leadership, good engineering and good management."

Triumphs

Using this formula, JPL under Pickering's leadership has accomplished the following major triumphs:

- On Dec. 14, 1962, the Mariner II spacecraft completed a fly-by of the planet Venus, culminating a 108-day journey of more than 180 million miles.
- On July 31, 1964, the moon, too, came under close scrutiny. With the spectacular flight of Ranger VII, 4,316 high resolution pictures (2,000 times better than those produced by earth-based optics) were radioed to earth. In February and March of 1965, Rangers VIII and IX sent back additional photos.
- On July 14, 1965, after a 228-day flight of more than 325 million miles, the first close-up pictures of Mars were radioed back to earth by the Mariner IV.

Inevitably, there have been failures. After five straight Ranger failures, Congressmen who hold NASA's pursestrings demanded to know why $250,000,000 hadn't produced a single good photo of the moon. There was talk of bringing in "hard-headed industrial management," making JPL a national laboratory and severing ties with Cal Tech.

Cool answer

Pickering refused to buckle or blame. At a Congressional committee hearing in Washington, D.C., he was asked if "personality clashes" between JPL and NASA officials were the cause of some of the troubles.

"I prefer not to answer that question," he replied coolly.

His quiet confidence won important friends. Representative George Miller (D-Calif.), chairman of the House Committee on Science and Astronautics, said, "Dr. Pickering is held in high regard by our committee. When he was in trouble, he knew he was on the right track—and kept to it. He has the good sense to recognize the technological limitations of the people he's talking with, and he's patient."

The upshot was that although an administrative officer was called in and some other organization changes made, JPL continues as the only NASA laboratory run by a private organization. And Pickering is still the boss of a major portion of America's unmanned space program.

Pickering meets once a month with his senior staff, once a week with a smaller executive council. Rarely does he make a decision

Bill Pickering escorts Princess Margaret on a Jet Propulsion Laboratory tour during her recent U.S. visit. His job spans space technology, diplomacy, press conferences.

A photo album of Ranger moon pictures became the center of attraction for President Lyndon Johnson at a party. Pickering pointed out potential landing spots.

without giving these men an opportunity to express their viewpoints.

Pickering says that the biggest problem in space science is deciding what paths to follow:

"Space projects are large and expensive in terms of money, talent and time. Technology has reached the point where there are many lines we can follow, and many proposals are put forth.

"The paths that are chosen affect the national interest and are paid for by the people of the United States. Thus, in view of the complexities involved, decisions at the top can be most difficult. Fantastic things can be achieved in space, but they must be the right things—the vital, important things."

Pickering lives in a whirlwind of exploding space age technology, administrative detail, diplomacy, political balances, scientific meet-

ings, speeches, press conferences and transcontinental plane flights.

One of his recent days went something like this:

He left his Spanish-style home in Altadena and drove to JPL's modernistic buildings in a rustic canyon near Pasadena. He arrived at his ninth-floor office at 9 a.m. There he conferred with staff associates, signed letters and contracts, conferred with Robert J. Parks, project head of Surveyor.

Lunch in Los Angeles

Just before noon, he boarded JPL's helicopter and flew to downtown Los Angeles to introduce Werner von Braun, in the afternoon, he returned to JPL for more meetings, telephone calls and dictation. After dinner, he introduced von Braun to another audience. He reached home at 11:30 p.m. and prepared to leave for Washington, D.C., the next morning.

"He thrives on activity," said an associate. "If he runs out of work, he's like a trapped animal."

With all this crushing responsibility, Pickering stands on no ceremony. To friends and associates, he's just Bill Pickering.

"He's not only a brilliant scientist," said another co-worker at JPL, "but a warm and intensely vital human being—with a deep understanding of another man's problems. I've gone to him and confessed a stupid boner, and he's just laughed. It takes a big man to do that. But he knows—and I know —it won't happen again."

University scientists don't make much money. Pickering and many others at JPL could double or triple their salaries if they quit and went to work for private industry. Why, then, do they stay? Because of the unique atmosphere that Pickering has created.

Freedom for research

"Only here," said a JPL engineer not long ago, "can we find intelligent companionship and the freedom to do the whole job in research."

Like Vice-President Hubert H. Humphrey, Pickering is the son of a pharmacist. He was born on Christmas Eve, 1910, in Wellington, New Zealand—and still retains a slight trace of an accent. When he was quite young, his parents died and he went to live with his grandmother in Havelock, a village of about 500.

Life in Havelock

As a school boy, young William earned "A's" in mathematics, physics and chemistry, and was a member of his school's championship rifle team. One anecdote has it that he was the first person in Havelock to acquire a crystal radio set. He scandalized his grandmother by tuning in dance music from Australia on Sunday.

After a year's attendance at the University of New Zealand, Pickering was invited by a wealthy uncle, H. B. Douslin of Glendale, Califor-

Pickering studied balloon warfare, worked on missiles before heading JPL.

nia, to attend "a good technical school in southern California—Cal Tech." Pickering enrolled and was graduated with an A.B. in 1932 and a Ph.D. in 1936. He became a naturalized citizen in 1941.

Teaching and research

Pickering stayed on at Cal Tech to teach and do research with Robert A Milliken, founder of the institution and a Nobel Prize winner in physics. He and Milliken traveled to India and Mexico to study cosmic rays. They attached geiger counters to balloons and sent them 100,000 feet aloft—man's highest penetration of outer space up to that time.

During World War II, Pickering's work consisted of studying Japan's incendiary balloon warfare. It was a rather bizarre scheme: Balloons released in Japan would be carried across the Pacific by wind to start forest fires in Washington, Oregon and California—thus demoralizing the United States. Pickering gathered bits and pieces of the few balloons that did reach the Pacific Coast, constructed working models to learn how they operated. He found them ingenious—but relatively harmless.

In 1944, Pickering joined the newly-organized Jet Propulsion Laboratory in charge of electronics. After the war, he went to Germany with Dr. Theodore von Karman, head of JPL, to study German missile development. In 1949, he was put in charge of developing Corporal, an experimental liquid-propelled supersonic missile, and later worked on Sergeant, the Army's solid propellant missile. When the directorship of JPL became vacant in 1954, Pickering was a logical choice.

When Pickering was still an undergraduate at Cal Tech, a classmate named Gordon Bowler took him home to Pomona, California, one weekend to meet his parents. There, Pickering also met Gordon's sister, Muriel, on holiday from the University of Chicago. They were married two years later and now have two children, William, 25, and Anne, 21.

Weekend pleasures

When the children were younger and Pickering did not carry the load he does now, the family would take summer and weekend trips to fish, hike and collect rocks.

But he doesn't have much time for vacations or hobbies these days.

"I even miss puttering around in the laboratory," he said not long ago. "I'd like to get my hands dirty more often."

Although Pickering is still carried on Cal Tech's roles as a professor of electrical engineering, he does not have much time for formal teaching either.

In a larger sense, though, Picker-

ing's "students" have become the whole world. Even before his name was in headlines, reporters would seek him out at scientific meetings because he could explain complex ideas in layman's language. And, in spite of heavy duties, he still manages to discuss America's plans for probing deep space before TV audiences, church groups, and businessmen's luncheons.

He is convinced that politicians should know more about science, and that scientists should know more about politics. He also believes that such mutual understanding is slowly evolving.

"The public, too, has a better understanding of science than ever before," he said. "However, there's still the problem of pseudoscience being mistaken for true science. There are too many fantastic things going on in real science to be impressed by the pseudo stuff."

And one of the men who is making the fantastic things happen is Bill Pickering.

New era in brain surgery

by Arthur J. Snider

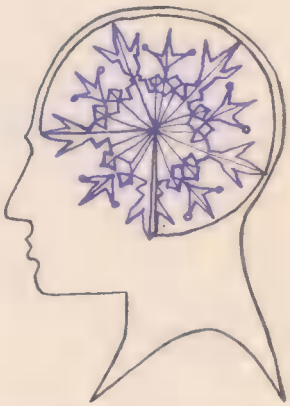
"Cold-blooded" brain surgery is a new technique that permits operations on the human brain with the circulation stopped for as long as 30 minutes. It makes possible brain surgery on conditions previously considered inoperable. Normally the brain cannot be deprived of oxygen and glucose for more than three minutes.

The new technique depends on lowering the metabolism of the brain cells, and thus their need for oxygen and glucose, by "preferential cooling."

Dr. Robert J. White, associate professor of neurosurgery, Western Reserve University, Cleveland, explains that brain cooling is achieved by shunting the blood from the body through a heat exchanger where the temperature is lowered from a normal 98.6° to 50° F. The blood then is fed back into a neck artery for circulation through the brain.

By the time the blood has traveled through the brain, picking up heat, and returned to the body, it has risen to 95° F, enough to maintain normal function of the heart and other organs.

The brain surgeon now has the same operative environment as the heart surgeon who uses the heart-lung machine. The development also makes possible complex brain surgery outside of large medical centers. Hospitals without elaborate equipment can easily use the shunting device.



Furthermore, the method promises to reduce markedly the time required in the operating room because it will not be necessary to rewarm the patient as is now required under total body refrigeration. The brain is automatically rewarmed.

The method was used by Dr. White recently in transplanting a brain from one dog to another. The brain lived for two days. How-

ever, it did not function as a "mind" because no neurological connections were made.

While the Russians have transplanted the upper portion of a dog's body, including its head, to another animal, transplant of the brain as an isolated organ had not been accomplished before.

Long range purpose of this research is not the transplant of human brains, a procedure that has moral, legal and ethical implications. Rather, Dr. White points out, it is hoped to obtain a better understanding of diseases that afflict the brain.

The expectant father

In the care and management of the expectant father, Dr. George Schaeffer, Cornell University Medical College obstetrician, puts him on the medical team.

The father is urged to come to the doctor's office with his wife early in the pregnancy.

"When properly indoctrinated, the husband can be a useful ally to the doctor," the physician points out in *Postgraduate Medicine*. "In her excitement, the pregnant woman frequently forgets or misunderstands verbal instructions. Some husbands jot down the answers and are in a position to explain them to their wife at home.

"In explaining that the pregnant woman runs added risks from extreme weight gain, including toxemia, shortness of breath, discomfort and cluminess, and that she may find it difficult to reduce afterward and thus remain obese, I have stressed that this is an opportunity for the prospective father to improve his own physical condition by watching his diet as well as hers. He can help by eating sensibly in her presence and resisting the temptation to bring home candies and other fattening treats or gorge himself in his wife's presence with foods that are forbidden to her."

A man's reaction on first learning he was about to become a father may provide a clue as to whether he will be a good husband and father, Dr. Schaeffer continues. If he is happy not only for himself but also for his wife, for the fruition of their marriage and for the child, he probably will be a good husband and father. If, on the other hand, he boasts of his self-sacrifice, he could fail in both roles.

"To a great extent, his success will depend on the kind of human being he is, and that was largely determined many years ago during his infancy, childhood and adolescence," the obstetrician added. "It is probably too late to make basic changes in the husband's personality, but this is a good time to have him examine his virtues and defects."

On the controversial question of whether the father should be in the delivery room, Dr. Schaeffer stands with the majority of hospitals. He forbids it.

Personnel entering the delivery room must be properly dressed.

While this might not entail difficulty for one individual delivery, it is time-consuming and expensive for the hospital that has 15 to 20 deliveries.

"Although the infant usually cries immediately after being born, there are occasions when it requires suction and resuscitation—procedures which to a lay person may appear extremely frightening and more drastic than they actually are," the obstetrician notes. 'The impact of this strain may remain with the father for some time."

Unborn heartbeats

A device about the size of a flashlight can detect the first fetal heart sounds at the age of 10 weeks, when the unborn baby is about two inches long. This is earlier than sounds heard with a standard stethoscope.

The instrument, held to the skin, generates ultrasonic waves. Their frequency is altered when they are reflected from moving particles in the fetal blood stream.

The ultrasonic waves can be converted to audible sound so the mother can listen through head phones.

The instrument was described before the National Academy of Sciences by Dr. Robert F. Rushmer, University of Washington professor.

Best new drugs

The seventeen foremost drugs of recent years have been selected by a panel of 170 leading United States and foreign medical clinicians and researchers for *The Medical Letter*.

They are: (1) Chlorothiazide, the first oral thiazide diuretic for the treatment of high blood pressure and water retention by the body. (2) Spironolactone, a diuretic used alone or with other diuretics. (3) Imipramine, effective in many patients with mental depressions. (4) Griseofulvin, an oral drug in the treatment of many common fungus infections of the skin and nails. (5) Amphotericin B, the first reliable weapon against serious systemic fungus infections. (6) Semi-synthetic penicillins, effective against organisms resistant to ordinary penicillin.

(7) Anticancer drugs, not curative, but capable of bringing improvement lasting from a few months to several years. (8) Triamciolone acetonide, a steroid preparation helpful in many skin disorders. (9) Phenformin, an oral drug that enables many diabetics to control blood sugar levels without daily insulin injections. (10) Nalor-

phine, a narcotic antagonist which combats both withdrawal symptoms in drug addicts and the respiratory depression caused by excessive doses of narcotic drugs. (11) Sabin live-virus polio vaccine. (12) Measles vaccine. (13) Halothane, a non-explosive anesthetic agent that has virtually replaced ether in the operating room.

(14) Oral contraceptives and (15) intrauterine contraceptive devices. (16) D-penicillinamine, the best oral agent for the treatment of Wilson's disease, a rare disorder in which large excesses of copper are deposited in various parts of the body. (17) Gilucagon, for the emergency treatment of insulin shock when the patient cannot take sugar orally.

Why we blister

The common friction blister, tormenter of millions of Americans and the great d i s a b l e r of marching armies, is finally coming under laboratory scrutiny.

A "rubbing" machine has been developed to create blisters on the soles and palms of volunteers at Letterman Army Hospital in San Francisco.

From the studies now underway it is hoped that information will emerge on the best foot gear and clothing to prevent blisters and, more fundamentaly, give some biochemical insight into conditions that make some people more vulnerable to blisters than others.

The skin of volunteers is rubbed with different materials—leather, cloth and plastics—for v a r y i n g lengths of time, at varying speeds and with varying amounts of moisture added. Blisters do not form when the skin is completely dry or very wet.

Only the hands and feet blister, explains Dr. Leonard Fishman of Letterman. The reason is their physical characteristic. The tough, horny outer skin will move when friction is applied but the underlying layers of skin, being "bound down," do not. The result is a shearing effect, followed by a tearing of tissue.

Watery fluid from the blood vessels fills the torn area, forming a cushion. The fluid becomes an excellent culture nutrient for bacteria that lurk about the skin.

Perils of dreaming

Painful attacks of angina pectoris can be triggered during sleep by dreams involving physical exercise or stressful emotions, according to a study reported in the *Annals of Internal Medicine.*

Duke University doctors monitored the sleep of 10 patients with a history of angina pectoris, a heart ailment marked by sudden, sharp pains caused by an insufficient blood supply to the heart muscles.

They determined that the patients were dreaming by observing rapid eye movements, respiratory patterns and an electroencephalo-

gram. A continuous record was kept of their heart action by an electrocardiogram.

During the 12-night study, four of the patients experienced a total of 39 episodes of angina associated with dreams involving physical activity or emotional upsets concerned with fear, anger or frustration. The angina attack shortly awakened them.

Measurements showed the entire incident from dreaming to onset of pain and awakening would last about 10 minutes.

Unplugging arteries

Jets of carbon dioxide are being used to remove plugs in blood vessels at King's County Hospital, Brooklyn. The first report on 12 patients said results were "most gratifying."

The plugs form as a result of hardening of the arteries, a condition brought about by the accumulation of cholesterol or other fats. In the past, treatment has frequently been removal of the clogged segment of the artery and replacement with a vessel graft.

Sending short bursts of gas into the diseased artery segment may prove to be faster, more complete and less traumatic to the patient, according to Dr. Sol Sobel.

Emotional rashes

A physician advises his colleagues to look for emotional factors rather than organic causes of skin rash if the patient:

- Is an unhurried, deliberate meticulous undresser ("while you wait").
- Deposits his shoes on the treatment table.
- Shakes out his socks.
- Is a marathon talker.
- Is an adult son whose mother hovers at his side through the examination.
- Having "been everywhere, gives you one last historic chance to cure him."

"An almost endless list might be compiled of traits and signs which mark the patient with emotional problems," comments Dr. Morris W. Waisman of the University of Miami. "Certainly a classic example is the patient who reads to you leisurely, one by one, a multitude of detailed complaints itemized on a sheet of paper."

It is usually difficult to penetrate the patient's psychological makeup, Dr. Waisman adds, because he wishes the rash to be organic.

INVENTOR OF THE MONTH

Hero-inventor

KFS

A SEA hero doubles as *Science Digest* Inventor of the Month. He is Capt. Kurt Carlsen, above, who some fourteen years ago received many decorations for remaining alone aboard his ship after it split in two.

Captain Carlsen was recently awarded Patent 3,225,732 for a reversible marine propulsion system. His jet turbine engine is mounted vertically and exhausts up the ship's stack.

As such an engine is most efficient at a high constant speed and would be difficult to reverse, Carlsen's is equipped with a differential mechanism that makes possible controlled propulsion forward or astern.

The captain, now master of the American Export Isbrandtsen Lines freighter *Exbrook*, was on a voyage to African ports when his patent was issued. His North Atlantic adventure came while he commanded the freighter *Flying Enterprise*, which encountered a storm out of Hamburg just before Christmas 1951.

On Christmas Day, the ship was struck by a 60-foot wave, which cracked the plates. Four days later, Captain Carlsen ordered his crew of 40 and his 10 passengers to abandon the crumbling ship, then 320 miles west of Falmouth.

On Jan. 5, 1952, a rescue tug put a line aboard, and three days later what was left of the *Flying Enterprise* started toward Falmouth under tow. But on Jan. 10 it foundered in another storm. Captain Carlsen was rescued from the sea by a tug appropriately named the *Turmoil*.

Besides foreign decorations, he received U.S. Congressional, state and city honors. He was made master of a successor ship, the *Flying Enterprise II*. Last year, after an extended vacation ashore, he went back to sea on the bridge of the *Exbrook*.

Carlsen's gas turbine engine drives the propeller through a planetary gear controlled by an electric motor or other power source. From the bridge, according to the patent, the propeller can be governed at any speed from full ahead to full astern by regulating the speed of the electric motor, without shifting gears or changing engine speed.

—Stacy V. Jones

Soundless, languageless radio

A SELF-powered push-button message device to send voiceless communications has been developed for the U.S. Army by Radio Corporation of America.

The device, called a Jungle Message Encoder-Decoder (JMED), will permit voiceless communications between allied jungle fighting groups even if they speak different languages. The device operates in conjunction with standard Army pack radios to send and receive 32 special five-digit messages.

To operate JMED, a soldier in the field sends a selected message by operating five switches on JMED, each switch transmits an "X" or an "O." When the fifth switch is activated, the message is sent and the unit is ready for the next transmission or reception. Thirty-two messages, tailored to the needs of jungle troops, contain five digits each and are shown on a display panel on JMED.

To read a message, the code is checked against a printed message card. Pictures, symbols or the user's own language on the cards eliminate the need for translators and help avoid misinterpretation, according to E. D. Simshauser, RCA project manager for the device.

JMED weighs about three pounds and draws power only during transmission or reception. Rechargeable, self-contained batteries supply enough power to send or receive 200 messages.

The coded messages overcome the communications barrier between friendly troops speaking different languages and provide a means of communicating silently in dense jungle where the enemy may be only a few yards away.

The JMED is being tested at the Army Electronics Command at Ft. Monmouth, N.J.

Carbonless paper

The secretary's bugaboo, carbon paper, was overcome recently with a carbonless paper containing a built-in image. "Action" paper, manufactured by the 3M Company, uses no ribbons nor inking mechanisms. The "ink" is two colorless reactive chemicals. One chemical is contained in a tiny synthetic capsule shell, so small that 150 would just encircle a human hair. The other chemical is impregnated in the paper. Both are mixed with pulp during the paper making process. The cushioning effect of a paper "web" protects the tiny capsules from rupture. The pressure of a ballpoint pen, a typewriter

key or a business machine breaks the capsules, producing an instant, dry image.

Approximately 100 million capsules are located in a piece of standard 8½ x 11 inch typewriter paper. About 30,000 capsules break when the letter "o" on a typewriter strikes the paper.

There are several advantages to the carbonless paper. It is strong enough to be used in teleprinter operations and eliminates the need to separate the carbons from imprinted rolls. It also saves time spent inserting carbon paper and makes extra copies uniformly clear.

This 10-megavolt accelerator utilizes a mercury vapor instead of hydrogen gas.

New accelerator

A new system of ion-feeding which doubles atomic particles' energy has been incorporated in Japan's largest electron accelerator. The 10-megavolt accelerator was just installed in Tokyo University's Physics Laboratory by Tokyo Shibaura Electric Co., Ltd.

The Van de Graaff-type tandem accelerator utilizes a mercury vapor jet instead of hydrogen gas as the electron adder of the negative ion source, a process patented by Toshiba. Large diffusion pumps are unnecessary to the system, which is being used for advanced particle research.

The negative ion source, negative ion accelerator and positive ion accelerating components are arranged in series. Negative ions are added from the ion source on top of the accelerator and then speeded up. In mid-phase, they are converted to positive ions and again accelerated. Their energy levels are doubled in this process.

The apparatus will be available for export. The manufacturer is Japan's largest maker of electrical and electronic equipment.

Comfortable contacts

Contact lenses may become more comfortable when made of a soft plastic recently invented by two Czecholovakian scientists.

The plastics, according to Patent No. 3,220,960 are called hydrogels. The materials are hydrophilic, "water-loving," and become saturated with the lens wearer's tears.

The hydrogel plastic is so soft there is almost no sensation on the lid or cornea according to Dr. Allan A. Isen, a Buffalo, N.Y., optometrist. He has been testing the material with his patients. He compared the hydrogel favorably with hard plastics now used.

Prof. Otto Wichterle, director of the Institute of Macromolecular Chemistry in Prague, and Dr. Drahoslav Lim, a research scientist, invented the materials.

The National Patent Development Corporation holds a license for the Western world. The material is being produced by the Princeton Research Corporation in New Jersey. Sublicenses have been granted to two lens makers.

Speed hearing

A harmonic compressor has been developed by Bell Telephone Laboratories, Murray Hill, N.J., to allow "speed hearing" of recorded speech at a rate equal to speed reading. The device designs have been given to the American Foundation for the Blind for possible use in making recordings for the blind.

The harmonic compressor permits recordings of the human voice which can be played at twice the normal speed while retaining normal voice pitch. The high-pitched babble sound of the usual recording at double speed is eliminated.

Speech is fed into a bank of 36 bandpass filters which separates the speech into different frequency components. The output of the bank of filters is sent to 36 frequency dividers which halve the frequencies of the narrow-band filters. Then the signals go to networks which remove distortion and combine the 36 halved signals into one signal. The frequency components are then half the original value. These harmonically compressed signals are recorded on magnetic tape and the halved frequencies can be restored to their original values by doubling the playback speed.

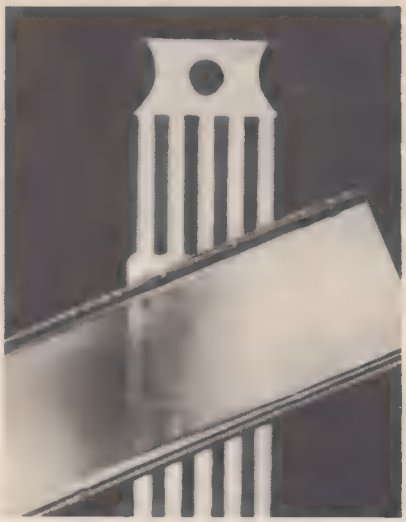
Drs. M. R. Schroeder and R. M. Golden of Bell Labs adapted the harmonic compressor to the Foundation's needs. They simulated the device on a digital computer which proved the effectiveness of the design without requiring actual equipment to be built. The engineering division of the American Foundation for the Blind will develop the hardware from the designs.

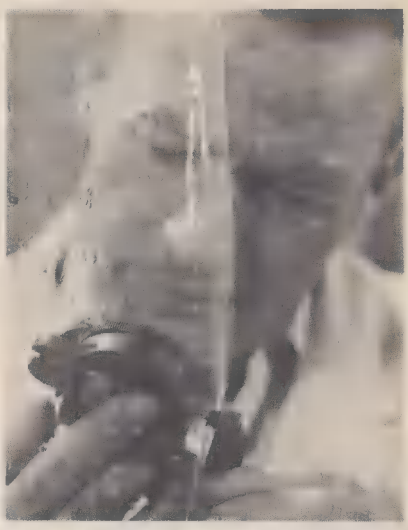
The Foundation records Talking Book records for the U.S. Library of Congress for free distribution to blind persons throughout the country.

Heated highways

Winter snow and ice storms can be banished from highways with road-heating equipment made by a Scottish firm.

The Road Icelert can switch on electric heating mats within the road, warn oncoming traffic or send signals to stations so sand can be spread before ice forms. The so-





Efficiency improves with development of materials. Left is a Dow Corning silicon web semiconductor. General Dynamics made membrane (right) to purify brackish water.

phistication is proportional to the price tag.

Four main parts make up the equipment: a road-surface-temperature-sensing probe, a road-surface-moisture-sensing probe, a snow and ice detector probe and a remote electronic control box for the connection of the three probes. The control box is attached to the main electrical line. A temperature control knob in the box can be adjusted to close a relay at any desired road surface temperature between 25 and 45° F.

If snow or ice is sensed, the road-heating equipment closes five degrees above the set temperature. Thus, when the road is wet and the temperature falling, the heating mats switch on before ice is formed.

The temperature-sensing probe is 1⅞ inches long and about ½-inch in diameter. It travels through a ¾-inch conduit laid close to the road surface. If road-warming is included in the equipment, the probe is located where it will be affected by the cable-conducted heat.

The snow/ice sensing probe can be placed on or off the highway and contains a heating element. The heater is fed from a potentiometer on the control box. The moisture-sensing probe is placed level with the road surface. Both probes are four inches in diameter and less than two inches long.

The equipment sells for $299 f.o.b. Scotland. Manufacturer is Findlay, Irvine Ltd., Penicuik, Midlothian, Scotland.

How to trace a turtle

by Daniel Cohen

IT IS REALLY astounding how little we know of the behavior of wild animals.

The green turtle, for example, can migrate regularly across 1,400 miles of open ocean and unerringly find a pinpoint of land in the South Atlantic. What navigation system does it use to accomplish this remarkable feat?

Closer to home, it is surprising to learn that scientists have only the vaguest ideas about how the common mule deer spends its days. How far does it travel? When and

Left: Dr. Archie Carr's assistants attach a balloon to a green turtle. The balloon will float to mark the turtle's location.

Right: Turtles can always crawl directly toward the sea, even when they can't see. Blindfolded turtle is a moving example.

Below: Turtles are marked with metal tag on flipper. Some turtles have been recovered 1,400 miles from tagging point.

Marlin Perkins, left, and Dr. Archie Carr, center, examine green turtle. Turtles are turned on their backs to transfer pressure from soft underside to harder shell on back.

where does it feed?

Scientists' attempts to answer these questions will be explored on the NBC television show, Wild Kingdom, on Feb. 27.

The show, starring Marlin Perkins and Jim Fowler, is titled "Challenge to Survival." Exact knowledge of the habits of wild animals is no longer a matter of idle scientific curiosity, it is a matter of survival. The green turtle is

. . . and follow a deer

already extinct in many places where it was once common. In order to preserve and increase the numbers of this interesting and potentially valuable animal, its migration patterns must be understood. Study of the green turtle will also answer questions about animal navigation.

The mule deer does not face the immediate threat of extinction, but in order to keep it more successfully in America's shrinking wilderness areas, scientists must know more about its range. In addition, the techniques of keeping track of an animal's movements by radio, developed with the mule deer, are being used in the study of threatened animals like the grizzly bear.

However, it is the work with the green turtle that is most critical and ingenious. On Wild Kingdom, Perkins visits Dr. Archie Carr, the man who knows more about these 500 pound sea turtles than anyone else in the world. At that, Dr. Carr admits that even his account of their life is still "fragmentary."

After marking hundreds of turtles with numbered metal tags, Dr. Carr has discovered that they sometimes go hundreds of miles from the beach on which they were hatched, to the area where they mature and feed. A few years later, they are able to return to the same narrow area of beach on which they were born.

Dr. Carr has attached floats and large helium-filled balloons to some turtles to trace them in the water for short runs. A more ambitious project is planned for the future with the aid of the National Aeronautics and Space Administration.

Radio-equipped turtles would be tracked in the open ocean by satellite. Dr. Carr says, "Each time the satellite passed within range of the . . . transmitter a signal would be received; these signals rebroadcast to a control station, would allow a precise plotting of the position of the turtle."

Prior to the show, Perkins discussed the potential economic importance of the green turtle. It is already well known to gourmets throughout the world as the principal ingredient in turtle soup. Yet this large, protein-rich reptile lives, or once lived, in areas that face a chronic protein deficiency.

It is thought that the turtles might be persuaded to return to some of these beaches. (In the Carribean they have been exterminated near almost all populated areas. And turtles born on different beaches have, thus far, stubbornly resisted changing their breeding grounds.) But if it could be done and if the population could be persuaded to harvest the turtles carefully rather than massacring the females as they crawl upon the beach to lay their eggs, a major new food source might be developed.

Top: Naturalist aims at deer with gun that shoots drug-filled dart. Drug will harmlessly immobilize deer in 4 to 7 minutes.

Center: Marlin Perkins examines radio transmitter, attached to drugged deer that will send out signals for a 2-mile range.

Bottom: Deer, with transmitter and brightly colored neckband that will permit it to be spotted, continues on its way.

THE ASTRONOMY STORY

Yes, there are canals

Dotted lines frame Mars canal spotted by British astronomer in Mariner 4 photo. A U.S. expert says he's spotted others.

by Hubert Pryor

MARS really does have canals—only they're not canals. That's the latest word after months of discussion of what was revealed in the close-up photographs of the planet taken by Mariner 4 when it flew by Mars last summer.

The definite assurance of the existence of the canals comes from Dr. Clyde W. Tombaugh of New Mexico State University. He discussed the story of Mars, as science has pieced it together to date, in a symposium at the 132nd annual meeting of the American Association for the Advancement of Science held during the last week of 1965 in Berkeley, Calif. He enlarged on his findings at a press conference.

"I've seen people so s t r o n g against canals," he said, "I'd like to have their eyes tested."

Not waterways

Dr. Tombaugh doesn't mean that the canals are actual waterways made by intelligent beings. The term "canals" first came into use late in the 19th century, when there seemed to be no other reasonable explanation for the webs of lines that crisscross the planet. Percival Lowell, the American astronomer who died in 1916, proclaimed that the canals were strips of vegetation bordering water courses of some kind. Even in later years, when it became evident that water on Mars was extremely scarce if present at all, the term "canals" persisted just because everybody had gotten used to calling the lines that, whatever they might be.

Then came the Mariner 4 flyby. Mars buffs the world over scrutinized the photographs it had taken. Craters, yes. Light patches and dark patches. But no canals.

Not only that: Mars s e e m e d dead. Nobody said so conclusively,

but there was gloom. And the seeming absence of canals deepened it among the enthusiasts who would give humanity companionship somewhere in space, for the canals had come to symbolize the possible existence of intelligent life on Mars.

30-mile streak

But British astronomer Eric Burgess reported in the fall that he had pored over the Mariner 4 photos. In No. 11, he announced, he had seen a streak 30 miles long that could account for one of the canals seen by telescope from Earth. He said the canals could be rift valleys.

Now Dr. Tombaugh, who has been studying Mars for around 20 years, has made it clear there can be no doubt about the canals. He described exactly where the Mariner 4 photos show canals, as he told the AAAS meeting: "Even to this day, there are those who would discredit these features as illusions. Their visibility is highly dependent on good telescope optics and rare atmospheric conditions free from turbulence. Few are patient enough to provide the proper telescopic parameters and then to wait on very favorable conditions necessary to see such delicate detail." And he added:

"A scientific phenomenon is *not* solved by wishing it out of existence as some skeptics have attempted to do. The best photographs do show the stronger canals and oases, although somewhat poorly. A well-trained, good, normal eye is still superior to the best photographs for fine details for any kind of delicate planetary details.

Independently drawn

"Whatever the canals may be, it is significant that skilled planetary observers draw them in the same areographic positions independently from different stations. Often such delineations are incomplete because of unequal attention on all parts of the planetary disk. This skill is greatly underestimated by those who spend little time looking through the eyepiece of a telescope."

Does Dr. Tombaugh, who discovered the planet Pluto 36 years ago, have any theories about what the canals might be?

He does. He thinks the canals are fractures and faults in the crust emanating from oases, which is the name given to the dark spots appearing at intervals on the planet's surface.

Vegetation?

Dr. Tombaugh also links the oases and canals, as did Lowell, to the existence of life on Mars—not two-legged human life, but vegetation. The vegetation, he believes, changes color as it flourishes and diminishes with the seasonal advance and retreat of the Martian polar ice caps. With certain changes in color, the canals blend with the surrounding desert and seem to disappear. Sometimes, he added, des-

ert winds blow sand across the canals to obliterate them.

For the rest of his paper, Dr. Tombaugh described how the polar caps advance and retreat smoothly, indicating no unusual ups and downs on the planet's surface, and thus no seas, dried up or otherwise.

Permafrost, ice

What about water? It's there, but in "great scarcity," perhaps only as permafrost and ice.

Which brings us back to the canals and the indications of life in the form of vegetation along their "banks."

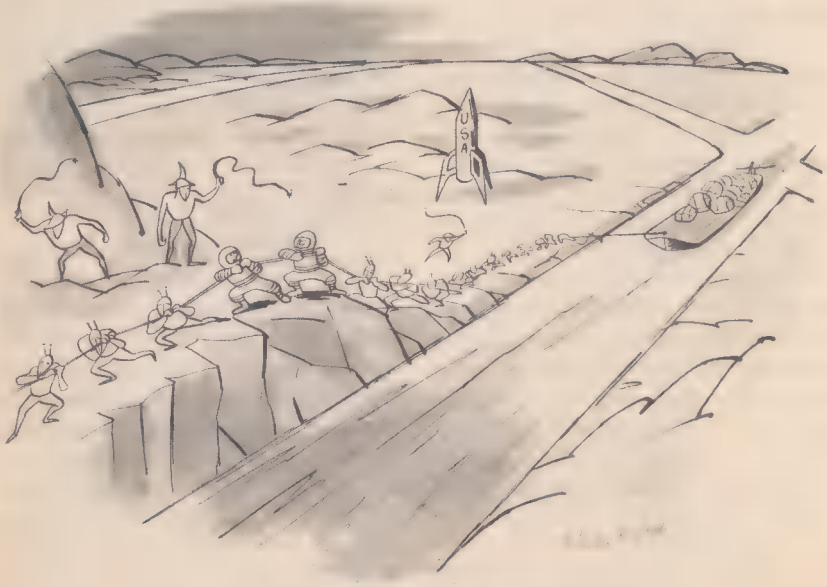
"The rare appearance of most of the recorded canals," said Dr. Tombaugh, "suggests that their visibility may depend on infrequent, gentle de-gassing along their courses, perhaps driving out some permafrost."

All this doesn't end the argument over Mars. But Dr. Tombaugh told his AAAS listeners:

"When the Mariner 4 pictures were received, many expressed great surprise at the cratered surface. They confirmed what I had deduced from my telescopic observations."

Then he read portions of an abstract of a paper he wrote in October, 1950.

It could have been written last July, when Mariner 4 sent its photos of Mars back to Earth.



"Well, you were right about one thing—
the canals on Mars are real."

How we get psychosomatic disorders

Dr Roy R. Grinker, expert on psychosomatic diseases, in his Chicago laboratory.

by Flora Rheta Schreiber and Melvin Herman

IMAGINE yourself as a human experimental subject, hooked up to a formidable array of apparatus. The experimenter leaves the room. Suddenly something goes wrong. There's a shower of sparks. After a moment the experimenter rushes back. "Hold still," he warns, and he fiddles with the apparatus. Finally the sparks subside. "How do you feel?" he asks.

What would your answer be?

The response a person gives to this planned accident-in-the-laboratory experiment designed to arouse anxiety, shows the defenses against stress and anxiety he uses in his life. A person pursuing a path intended to avoid trouble, might reply, "I just refuse to think about it." Someone else may resort to outright denial of concern, saying, "I figured you are a doctor and wouldn't let me be hurt." Still another, with no defenses, might say unabashedly, "I practically fell apart."

The investigators at the Institute for Psychosomatic and Psychiatric Research and Training of the Michael Reese Hospital in Chicago believe these responses to stress and anxiety are clues to psychosomatic diseases.

"If psychosomatic illness is to be understood, it is not the illness itself that must be studied, but the basic processes leading to it. All of us have defenses by which we avoid being stirred up. Otherwise, if we let everything bother us, we'd be at the mercy of the world," said Dr. Roy R. Grinker, Sr., director of the Institute.

He adds, "Anxiety long felt becomes unendurable. What we call

psychiatric disturbances are really abnormal methods some individuals take to avoid anxiety. In this way, some persons resort to the tragic escape into mental illness."

The particular form that defenses take is an individual matter and varies according to personality type and the physiological response to stress. In psychiatric interviews, calculated on the basis of the person's history to evoke strong emotional responses, it is possible to note the degree of anxiety, anger or depression shown by individuals who are subjected to stress. The physiological effect of emotion is recorded as changes occur in heart rate, blood pressure, the secretion of hormones by the adrenal cortex, and blood and urine analyses.

Stress variations

In this new research, Dr. Grinker finds support for his long-held view that physiological reaction to stress varies with the individual. In one person, the most marked response will be a faster heart beat; in another, it will be higher blood pressure; in a third, abnormal tension in a particular group of muscles. There are some persons with abnormal tension in all their muscles all the time.

These responses may mirror, or even actually cause, the particular type of psychosomatic illness to which a person may be susceptible. A person who consistently reacts to emotional stress with an unusually large increase in blood pressure may eventually develop permanently high blood pressure. One who reacts by tightening his neck muscles may eventually be troubled by a stiff neck and headaches due to radiation of the pain.

Individual response

The pattern of this individual response, though probably not inborn, is established early in life. Dr. Grinker points out that when an infant reacts to stress—such as hunger or cold—he reacts with his whole system; the infant gets angry, his face flushes, he cries, has a bowel movement and breathes faster. All his muscles are in action. As the child develops, this so-called "global" reaction is narrowed. The response that finally predominates, according to Dr. Grinker, is strongly determined by the way the child has been handled. In extreme cases of anxiety in adults, as was the case with soldiers treated, studied and reported upon by Dr. Grinker during World War II, there is a return to the broad undifferentiated "global" response of infancy.

The Institute research has revealed a distinct relationship between muscle tension and certain character traits. The study of muscle tension or tone was done by means of an electromyograph, a device that records a muscle's electric activity through electrodes taped to the skin. Under stress induced at the Institute, anxious persons showed muscle hypertension. When mental patients were criti-

cized, their speech muscles showed tension. Praise, however, relieved the tension.

A generalized muscular hypertension, according to Dr. Donald Oken, until recently associate director of the Institute, and the man who headed this part of the study, may not only be a reaction but also may be a defense that keeps emotions from being recognized. Dr. Oken believes that persons with a need to oppose strong impulses with strong controls end up with unconscious anxiety.

He adds: "Clarifying the psychophysiology of muscle tension should lead to a better understanding of psychosomatic illness in general, and of many cases of illness diagnosed as rheumatism, fibrositis or lumbago, in particular."

He declares that "treatment of patients complaining of anxious tension may be fruitless, and not without danger, if directed only at reducing tension." Merely reducing the tension through drugs may lead the patient into a "forced" relaxation, resulting in the loss of an essential part of his self-control mechanism. This loss, in turn, may lead to an increase in anxiety or the development of pathological defenses. Dr. Oken feels that some patients currently benefitting from medication that reduces muscular tension are those in whom psychological conflict is no longer acute. He stresses the importance of the relationship between anxiety and muscle tension by pointing to its complexity, and cautions that "patients cannot be treated as if they were merely collections of tense muscles."

Reducing tension with drugs may be dangerous, one authority says.

The new methods and viewpoints at the Institute represent a great advance between the amount of physiological effect with the intensity of the emotion that gave rise to it. The effort to pinpoint the crucial relationship was complicated by the fact that many persons have so-called "competent" defenses against emotional arousal. That is, even while showing physiological changes under stress, they remain outwardly calm, claiming to have experienced no change in feeling. Now these changes are being measured objectively.

Exorcising stress

Where a child who has been to the dentist plays the game of dentist over and over again with a playmate or her doll until the anxiety of the real experience is gone, she is exorcising stress.

By reliving and repeating a traumatic experience in our thoughts, we can master the anxiety originally associated with it. This is the point made by Dr. Stanley W. Conrad, assistant professor of psychiatry, Temple University Medical School and Hospital, Philadelphia.

The research at the Institute deepen psychiatric awareness of the

subtle problem of stress and how we cope with it.

In a paper delivered before the American Psychoanalytic Association, Dr. Mortimer Ostow, associate attending psychiatrist, Montefiore Hospital, New York City, made some cogent observations.

"Every mental illness," the doctor said, "begins with a struggle to establish or to maintain affectionate relations. The struggle is always painful. After a certain period, the patient may abruptly give it up and attempt to find substitute gratification by withdrawing into himself.

"The mantle changes of this syndrome include signs of detachment from other individuals and signs of extravagant self-love. The former becomes manifest in a certain aloofness and remoteness, a refusal to become involved in warm friendships. The latter is betrayed by cultivation of solitary pleasures and activities. Despite apparent normality, it conveys no true emotional communication, no real affection.

"This maneuver, when successful, spares the individual pain and anguish. At some time, however, it tempts him to rest content with this compromise, and to avoid efforts to resume normal emotional exchange with the natural objects of this affection. He will welcome the supplementary support for his narcissism afforded by the continuing but arm's length relation with his analyst, but will resist the latter's efforts to motivate him to attempt to undertake, once more, the engagement in love and true friendship with others. The treatment degenerates into a stalemate: it fails to progress, but it cannot be stopped."

Dr. Ostow added, "Drugs cannot make it possible for the patient to resolve the conflict which precipitates his illness, but they alleviate the pain of his withdrawal and permit a comfortable retreat into a state of narcissitic tranquility. This usually includes — psychosomatic changes. Most commonly one sees a stubborn obesity which resists all but the most stringent dieting. Sudden and paralyzing fatigue occurs, especially in the late afternoon. Allergies are often aggravated."

Chemical coding

A study at Yale, conducted by Dr. Neal E. Miller, the James Rowland Angell professor of psychology, is both scientifically and practically provocative. The significant finding of this study is that the brain operates in part according to a chemical coding system and that chemical coding in the brain seems to involve both the type of chemical and the place of action. New light is cast on how the brain works.

Knowledge of the code can presumably lead to new chemical means of influencing behavior. Dr. Miller's experiments so far are confined only to manipulating the drives of hunger and thirst, but are to proceed also to motivation, learning, fear and conflict. They already promise a practical outcome.

There is hope for the skinny and the obese. As Dr. Miller puts it,

Chemistry may hold hope for the obese, the skinny and alcoholics.

"Increased understanding of the hunger-regulating mechanism, which is so powerful that it is hard to get patients without appetites to eat more or obese ones to eat less, may help in the discovery of pharmacological ways of treating such disorders." This means that ultimately the drug store may legitimately hold answers to gaining or losing weight.

By chemical therapy, there is new hope, too, for alcoholics who drink much but eat little. This hope is founded on the first experiments in studies conducted by Sebastian P. Grossman, then a graduate student of Dr. Miller's, but now at the University of Chicago. Grossman inserted the chemicals by means of a hypodermic needle fitting inside another hypodermic needle that had been painlessly implanted in anesthetized rat's brain so as to reach a particular spot in the hypothalamus. In animals, as in man, the hypothalamus, a tiny part of the brain near the base, helps to regulate processes having to do with sleep, sexual activity, hunger and a number of other functions. Earlier work had shown that, when the particular area selected for the first Yale experiments was stimulated electrically, an animal would change its eating and drinking behavior.

The results were dramatic. Rats that had eaten to the point of satiety received, directly in the hypothalamus, scarcely visible crystals of nordernaline. The animals began eating vigorously within a few minutes and continued to eat for about half an hour. But when the same animals received in the same location the other type of substance, either acetylcholine or a close relative, carbachol carbamycholine chloride, the rats began vigorous and prolonged drinking. Hungry rats ate more than usual but thirsty rats drank less than usual. When applied to alcoholics, this would mean that one could step down the desire for drink and accelerate the will to eat.

Motivation in the form of hunger may be tied up with one kind of chemical transmission in the hypothalamus while thirst is linked with a different kind.

Stops hunger

When carbachol is introduced into certain areas somewhat removed from the one originally used, it has the same effect: it stops hungry animals from eating and makes thirsty animals drink abnormally long. This indicates that the eating-drinking center is actually a system and that it can be stimulated at various points. The Yale group finds that the key point, the central switchboard, almost certainly lies in the lateral hypothalamus. For, when this area is inactivated, stimulation elsewhere has no effect, whereas when other areas are inactivated, stimulation in the lateral hypothalamus still works.

TIPS AND TRENDS

We ARE going to do something about the weather. A Presidential science panel says more money and research are "mandatory."

Do phosphates prevent tooth decay as well as flourides? Tests are now under way with phosphate additives in a cereal and a dentifrice. Note: Phosphates are non-toxic.

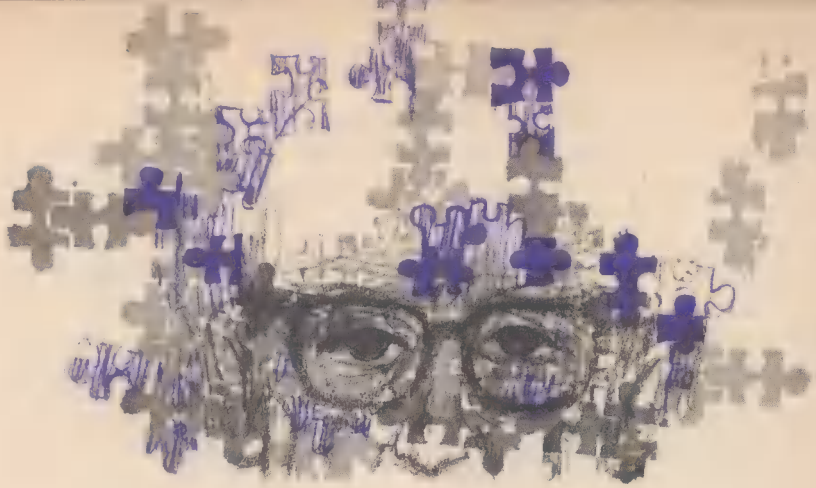
Mental hospitals are emptying. The number of patients is dropping at an ever faster rate due to tranquilizers, community care.

New "new math" textbooks will appear. For junior and senior high school students, they include scientific experiments to make them less abstract. Another math textbook, still experimental, teaches computer work.

Automation is NOT a basic threat to employment. So says a Presidential commission. It did find temporary dislocations, however.

Tangerines can clear up the sniffles. Florida scientists say the fruit contains synephrine, hitherto produced synthetically as a stimulant and decongestant. Oranges and other citrus fruits have lesser quantities.

The world food shortage may be solved. U.S. researchers have found a bacteria- and toxin-free way of producing a fish concentrate that's 80 p.c. protein. Hundreds of millions of people could be fed at a cost of half a cent per person per day.



Secrets of how we think . . .

Strange truths about our minds are emerging in experiments with computers and cameras.

SOME of the most exciting research going on in psychology today involves the use of computers to test hypotheses about how the human brain itself works.

This general area of research is usually called "the simulation of thought processes by computer," a phrase which is enough to put off many people immediately. Such an undertaking could appear to be an insult to human intelligence, and impossible to boot. But the men working in this field are not saying that the human brain is "like" a computer in the sense that its protoplasm resembles the components of the machine. What they are saying is essentially this:

The human being, when he is thinking, is processing information: He is manipulating symbols and patterns according to some organized sequence or sequences. We do not yet know much about the biological mechanisms by which these processes are carried out. But we need not wait for further physiological research in order to formulate some ideas about them, because we already know something about information-processing itself. If we can describe the organization, patterns, strategies by which the brain must act on information in order to perform certain tasks, we can leave for the time being the question of the biochemical functioning within

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the brain. Let us, then, form some hypotheses about how the human brain is organized to play a game of checkers, or to discern what should come next in the sequence AABBCCDD—.

Construct a model

The first thing to do after forming a hypothesis is to test it. One way is to construct a model based on the theory and see if it works. If you formulate a hypothesis about how a human being goes about solving a problem, how do you test that? In this case you are not wanting to determine if the person "works"; the fact that he solves the problem proves that. What you want to test is your theory about *how* he works.

Here is where the computer comes in. Flexible, rapid, capable of storing complex information, and —best of all—inexorable in its demand for precise instructions, the brilliant idiot provides the model for testing theories about the operation of the greatest information-processor of all, the human brain.

We intend to give simply a capsule description of some of the work now going on and the progress made thus far.

Three pioneers in the field of computer-simulation are Allen Newell and Herbert A. Simon of the Carnegie Institute of Technology and J. C. Shaw of the RAND Corporation.

In simulation the programmer, instead of trying to get the computer to perform faster and "better" than a human being, tries to get it to act in the same way, complete with false starts, going off on tangents, and so on. To do this, he writes a computer program embodying his theories about some aspect of human thinking. (This is analogous to the way a physical scientist writes his theories as systems of differential equations.) If the theories are correct and have been described to the computer with rigor and accuracy, the computer's tracing, when compared with both the overt moves and a running oral account given by a human being as he solves the same problem, will show that the computer "thought" exactly the way the person did.

Useful discipline

Testing the theories by computer rather than simply relying on human subjects' accounts of their thinking processes imposes a useful discipline on the theorist-programmer. Self-reporting is notoriously inaccurate and incomplete: we seldom are even aware of, let alone able to verbalize, everything we are considering, discarding, modifying, analyzing when we solve a problem. But the computer, because it demands such precise and detailed descriptions of the specific processes required for performing a task, forces the programmer to a constant refining and redefinition of his theory if he is to be able to instruct the machine on how to leap the gaps

People may break a problem into bits or ignore details for simplification.

left in the individual's self-reports and still arrive at a matching of his overt behavior. In addition, as with any good theory, the finite set of rules which constitutes the program should provide a more economical description of people's behavior than would the sum of their various reports, while at the same time it should allow the machine to regenerate that variety by playing and replaying the game according to those rules.

The Carnegie Tech group first wrote programs for a few particular tasks, such as finding proofs for theorems in symbolic logic, playing chess, and memorizing by rote. Then processes were analyzed and theories constructed for a number of different tasks in problem-solving, concept-formation, language-processing, and memorizing. Most exciting of all, though, and most inscrutable to the layman, is the recent development of general theories which are applicable to a number of diverse tasks. This is an attempt to get at the over-arching skills and abilities that we often call general intelligence—the diverse strategies by which the brain seeks solutions to unfamiliar problems when specific known skills are not sufficient in themselves.

In their General Problem Solver, Newell, Shaw, and Simon have developed a program that uses two general problem-solving techniques. One is means-ends analysis, which consists basically of breaking the big, "insoluble" problem down into smaller problems and then solving them, something we have all done or tried to do. The other technique is the planning method. The program ignores, or omits, certain details from the problem as originally stated, thus presumably simplifying it. A familiar plan is used to solve the now simplified problem, and that plan is then used as the strategy for solving the original problem with all its complications. Everything clear? Even if not, it should be apparent that a program that can use such powerful general strategies represents a significant step toward understanding how people use abstraction and generalization in solving problems.

Over-all search

The importance of programing theory and then testing the program is underscored by a discovery about over-all search strategies which was not recognized until it had turned up in two different problem-solving programs. Some programs (and probably some people) explore in depth: they pursue an immediate goal before considering another one. Others explore in breadth, searching simultaneously but not deeply along a number of lines. Neither of these strategies is particularly effective,

but a combination of the two is: a burst of exploration followed by a pause to evaluate and determine where to move next. Although this "search-and-scan" strategy is naturally not so simple as it sounds (if it does sound simple), the general principle is one that human problem-solvers might try to act on.

There are other cases in which simulation has brought to light principles with direct implications for teaching. Carnegie Tech men tested a program that had been written for solving algebra word problems of the type that are given to high school students. This program "translates" the word problems, step by step, into algebraic equations. A number of algebra students do the same. But other youngsters first translate the English prose into a "picture" of the physical situation and then translate this representation into equations. And those who perform this indirect rather than direct translation prove to be the more powerful problem-solvers.

Thus far, most of us have thought of the computer as a tool for performing boring work or complicated computations or announcing the outcome of elections before all the votes are counted—or even cast. Now we must think of it also as a means of helping man obey the ancient injunction, "know thyself."

. . . and how we learn

HARVARD University's Center for Cognitive Studies is a psychologists' hive of activity. At any time it may be the scene of as many as 50 experiments studying the various processes involved in thinking and learning. In one room, a computer is teaching an artificial language to a Harvard student; in another, a high-speed camera is recording the eye movements of a five-year-old as he scans a picture and reports on what he sees; in a third, a visiting Dane is describing intricate experiments on hearing to some of the Center staff.

The people associated with the Center are representative of a growing body of scholars—including philosophers, linguists, and anthropologists as well as psychologists—now concentrating their formidable intellectual powers on how people acquire, organize, evaluate, store, use, and communicate information about themselves and the world they live in.

In the field of psychology, those who follow this line call themselves cognitive psychologists. Although they do not think of themselves as educational psychologists, their existence and the fact that they are growing in number have extremely important implications for education. For some years education has suffered, in this country at least, from lack of attention on the part

of first-rate psychologists. Many of the best in the field have focused their experimentation—much of it performed with animals—on describing overt and observable behavior rather than the processes underlying it. The behaviorists made psychology a much more rigorous and scientific discipline than it had been previously, but few of their theories had practical consequences for the classroom. They cannot be faulted for not doing what they did not set out to do. Nonetheless, except for great strides made in testing and measuring mental ability, educational psychology in general went through an arid period. With the behaviorists otherwise concerned, the schools were by and large left to those interested in theories, many of them unsubstantiated, about motivation and adjustment, and few scholars were working on the infinitely complicated learning process itself.

By the 1950's, the need for sound new learning theories was more than obvious. This in itself, however, would not have been sufficient to draw the attention of top-flight psychologists had it not coincided with technological and theoretical advances that made it possible to study in a rigorous fashion complicated mental processes that had hitherto been largely inaccessible. Now there were new ways, and refinements of old ways, to study the human being's cognitive processes: How he sees and hears things, how he remembers, the role language plays in forming as well as expressing his thoughts, and how cognitive development takes place from childhood to adulthood.

These are the areas, broadly defined, in which the Harvard Center concentrates. Members of the Center's steering committee are from the fields of history, anthropology, statistics, logic, and education as well as psychology. Colloquia are addressed by distinguished speakers on subjects ranging from notation for the dance to statistical inference and historical causation. Close touch is maintained with Jean Piaget's center for the study of child development in Geneva, and closer to home, hundreds of nearby school children, plus a goodly number of adults, are yearly subjected to one or several of the myriad research experiments being performed.

Research is, of course, the heart of the matter. The examples which follow are simply a grab bag of specific instances of the kinds of problems being investigated.

Seeing and hearing

A fiendish device called the "ambiguitor" demonstrates that in seeing things, as in so many other areas of life, we often jump to conclusions that slow down our perception of reality. The ambiguitor presents a person with a blurred photograph of a perfectly common object, say, a fire hydrant. As the picture is slowly brought toward focus, the person looking at it inevitably gets ideas—and almost inevitably they are wrong ones—

If your first guess is wrong, it may interfere with later success.

about what it is. He then has great difficulty recognizing the object even when it becomes perfectly clear. Thus, psychologist Jerome S. Bruner, for example, saw the rack in which he parks his bicycle every day as a Renoir painting, and was unable to recognize its true and familiar self until the photograph had been in perfect focus for twenty seconds. (Incidentally, children of six recognize familiar objects almost as fast as adults do, so in this respect, at least, we do not grow keener as we grow older.)

This phenomenon, delay of recognition owing to the interference of wrong hypotheses, is a pervasive and strong one. Even giving a person hints in advance, or a running "yes" or "no" commentary on his guesses as he watches the photo coming into focus, does little good. The phenomenon is demonstrable in hearing also.

Memory

When given a list of words to memorize in order, most people have more trouble learning the middle than either end of the list. This phenomenon has been studied extensively by psychologists, and a number of different explanations have been proposed. An experiment was run at the Center in which, instead of memorizing a list, a person simply copied down nonsense syllables which were presented to him rapidly. Exactly the same kind of result was found. This suggests that, rather than reflecting some property of the nervous system, the phenomenon can be explained as a result of the cognitive strategy most people adopt when faced with such a task: when items are presented too fast, a person processes the first few items, falls behind and skips some, processes a few more, skips some, and so on. This is a function of processing time, the Center says, "where the processing may refer to anything from memorizing to copying to wrapping potatoes."

Language and thought

It is sometimes hard to draw a sharp line between the study of "memory" and the study of "psycholinguistics," which doesn't bother the people at the Center at all, since they are studying both. Here is one of many experiments where the two intersect.

People are asked to memorize four different kinds of sequences: normal English sentences, anomalous sentences having the same grammatical structure but no meaning, anagram sentences having the same words as the normal sentences but in ungrammatical sequence, and haphazard strings of words. As was expected, learning is fastest for the normal sentences, slowest for the

haphazard strings of words, and intermediate and about the same for the other two, thus showing that both grammar and meaning play roles in facilitating the memorizing of normal sentences. In trying to repeat sentences which are grammatical but meaningless, people tend to introduce other words which give meaning; in trying to repeat ungrammatical sentences, they tend to invert the word order (that is, make it correct). Thus they err on the side of making their responses more meaningful and grammatical than the materials presented to them.

Cognitive growth

Just as memory and language overlap and interact, so too do a child's acquisition of language and his general cognitive growth. (The role of language in most cognitive processes is so powerful that psycholinguistics is a major emphasis of the Center.) A great deal of experimentation is concerned with the acquisition and use of language by children at different ages; the general conclusion emerging is that as a child increases in his capacity to grasp concepts he learns greater subtleties of distinction in speech which, in turn, become important implements for further developing his conceptual skills. "When cause and effect are that closely related to one another," a member of Piaget's group at Geneva wrote recently, "it is difficult to say which is indeed cause and which effect."

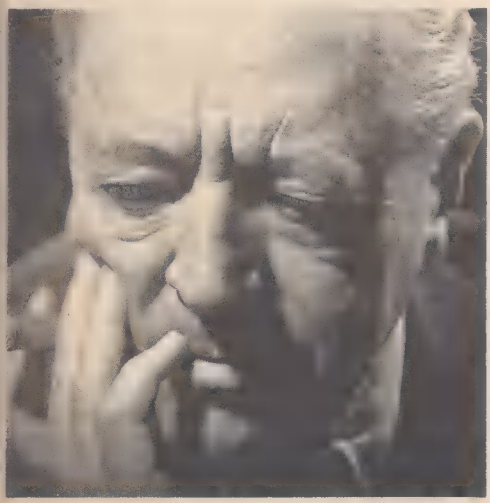
Teaching

Although research is the main activity of the Center, many members of the staff teach courses at Harvard, and a new doctoral program in developmental psychology has been started in which the Center plays an active role. Each year, a number of graduate students do their doctoral dissertations under the Center's tutelage, and several undergraduate students have done outstanding honors theses while serving as faculty aides. So the cognitive psychologists are adding to their number by training more of their own kind.

To return to the concern with which this article began— the improvement of education—last year Bruner was on leave, and with the part-time help of various members of the Center staff explored how some fusion could be achieved between developmental studies and the devising of educational materials and teaching methods. He once remarked that the real question in education is how long it takes to get from Widener to Wichita—from the development of a theory to its application in the classroom. Perhaps he can help to shorten the lag.

TRACES of the elements iridium and osium found in sediments on the bottom of the Pacific Ocean indicate that about 100,000 tons of cosmic dust fall on the earth each year. Research was conducted by John Barker, chemist, of the University of Chicago.

IIT—the house that



Architect Ludwig Mies van der Rohe (called Mies at IIT) guided school's expansion.

IN 1940, the Illinois Institute of Technology (IIT) faced a major decision. It was housed in a handful of inadequate buildings dating from before the turn of the century. A major expansion was in the works. But the trustees had to decide whether to do what so many other schools had done—move to an outlying area where there was inexpensive open land, and the promise of a quiet, rural-type campus. They decided, however, to expand on the original site, just south of Chicago's Loop, in an area that had become one of the worst slums in the nation.

Basic to the decision was the feeling that the destiny of IIT and the city of Chicago were linked, and

Mies built

Above: The architecture, planning and design building—Crown Hall—is Mies van der Rohe's crowning achievement. It has been declared on official Chicago landmark.

Below: In the foreground is the Gas Research Institute; beyond, the main body of the campus; in background, the Loop.

that the need for schools, particularly technological schools, was concentrated within urban centers.

The campus, which began with seven acres and now covers 120, was constructed along a plan conceived by the influential architect Ludwig Mies van der Rohe (head of the architecture department until 1958). Van der Rohe's functional glass and steel buildings are a far cry from the traditional ivy covered walls. They give the campus, a modern, almost science-fiction look.

Surrounding the campus are the affiliated IIT Research Institute, the Institute of Gas Technology and the Research Center of the Association of American Railroads.

Above: IIT physics student adjusts the institute's Van de Graaff generator.

Below: Dr. Henry Kneppler, head of the language, literature and philosophy department, leads an English class discussion.

IIT is justly proud of its large city and regional planning department. A student

IIT began as the Armour Institute of Technology in 1892. When the expansion began, it merged with Lewis Institute and the name was changed to Illinois Institute of Technology.

From the beginning, Institute's emphasis was on engineering and the physical sciences, but there always was a humanities program. Today, the emphasis is the same, but a program of great and sometimes exotic diversity has emerged.

The liberal arts courses are structured to deal with the impact of science and technology on culture.

There is, for example, Dr. Henry T. Hall, who heads the world's first (and only) department of proxemics, the study of how people relate to one another in space (the effects of crowding, room layouts, etc.). The philosophy department concentrates on the philosophy of

In the department and an instructor, right, lay out a city development plan.

science. The large language department is interested in mathematical linguistics, information and communication theory, and the relationship of man and machines.

In addition to a large architecture department, there is also a department of city and regional planning, and a planned interdisciplinary center for metropolitan studies, reflecting this big city university's interest in big city problems.

Other unique centers are also in the planning stage, for example, the Health Research Center, which will unite the life sciences with engineering, sociological and computer techniques. The Center for Computer Science and Systems Analysis, which, among other activities trains teachers and high school students in the use of computers, is now already in operation.

Above: Engineering models of the deep-diving submarine Alvin were tested by IIT in Evanston H.S. pool, Lake Michigan.

Below: Biological sciences have become increasingly important part of IIT's program.

President of the Illinois Institute of Technology is Dr. John T. Rettaliata.

Dr. Henry T. Hall has pioneered in the study how space affects living things.

The Anne Perlstein Memorial Fountain has become a familiar campus landmark.

Students stroll along a section of the campus known to them as "Mies Alley."

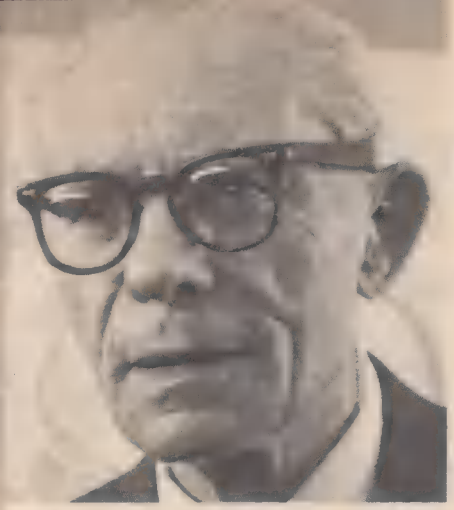
BY MOST yardsticks, IIT is the third largest technical school in the country (behind M.I.T. and Caltech), and certainly the largest in the Midwest.

At present, IIT has an enrollment of 1,997 day undergraduate students and 572 day graduate students. As is typical of an urban school, the evening division is much larger, having a total of 5,254 graduate and undergraduate students.

Although IIT is closely linked with Chicago, some 35 percent of the students come from outside the Chicago area, and there are over 300 foreign students. Student-to-faculty ratio is about 10 to 1.

The majority of students do not live on campus, but IIT does have dormitories for men and women and housing for married students, plus fraternity and sorority houses.

Since IIT expansion began, a large part of the blighted neighborhood surrounding the campus has been transformed. The University's



Dr. L. K. Hilbersheimer, chairman of Department of City and Regional Planning.

expansion plans dovetailed nicely with expansion plans of other nearby institutions such as Michael Reese Hospital.

At present, IIT is in the midst of a $25 million fund-raising campaign. So far it has collected about $10 million and University officials are confident that the full amount will be raised within a few years. About $10 million of the sum will be spent for academic development and $15 million on yet another ambitious building program.

Also part of the master plan for IIT's future is an adjacent 50-acre industrial research park.

This almost frantic expansion reflects the concern of men like Dr. John T. Rettaliata, IIT's president that "institutions like IIT clearly have a special responsibility for educational leadership in this Technological Age."

This is the sixth in a series on America's top science schools.

On the IIT campus is the John Crerar Library, one of the world's greatest libraries covering science, technology and medicine.

Students are housed in modern residence halls or in a complex of university-constructed fraternity and sorority houses.

The University's antiquated gymnasium will soon be replaced by a new all glass structure already under construction on campus.

Graphology—
science with a future

Handwriting analysis is beginning to get serious scientific attention in the United States. Here a leading graphologist tells what it can do and predicts important new advances.

by Daniel S. Anthony

What it is. Graphology has little to do with penmanship, so relax if you were one of the students who was cracked over the knuckles for your ungainly chicken scrawl. In fact, the more you deviate from the prescribed chirographic style, the higher the mark you are likely to get from the professional graphologist. The more your personal writing forms differ from the copybook standards, the more spontaneous or creative you are likely to be or become.

The graphologist's function is to observe, then chart, and then interpret precisely what your individual graphic deviations and variations mean from a psychological and/or physiological point of view.

Your handwriting is expressive of your individual personality because it is a product of your brain, aided or hindered by the conditions of all the rest of your physical mechanism.

All of your feelings, thoughts and actions are consciously and unconsciously coping for optimal psychic balance. Modern medicine tells us that the human body constantly seeks its own physical equilibrium, called homeostasis. Since your mind and body in the nature of the normal, living process automatically strive to achieve this state, the theory of graphology is based upon how you attempt to achieve your ego needs while satisfying your demands for tension, balance or release.

Your cortex activates your arm, hand and fingers when you write, just as it activates your facial muscles when you smile or frown. Both writing and smiling are responses to stimuli, but writing is an action and smiling usually a reaction. Fortunately for the graphologist, your handwriting is a highly complex action or expressive movement which combines your conscious, cognitive conditioning with all the unconscious perceptions, impulses, repressions, needs and drives which make up your individuality.

These projections of your habitual ways of behaving follow the patterns of your mental and physical forces are replicated in the

graphic patterns of your handwriting.

When you become elated or talkative after two cocktails, your handwriting increases in size and expansiveness. The feeling of slaphappy euphoria you may develop after two more drinks will cause you to lose more of your superego controls. The more you drink, the less organized you and your writing become. As your friends view you in this state, what they perceive is similar to the change the graphologist sees in your handwriting.

Research has proven that the states of anxiety and tension resulting from physical or mental ill health show up in graphic contractions and distortions. Experiments have likewise demonstrated that enthusiasm, elation and extraversion result in an expansion of the graphic movement.

With this simplified explanation, we are somewhat better prepared to approach the science of graphology. For this purpose, we have chosen the "illegible" and pictorial scripts of John F. Kennedy and his wife Jacqueline, because their lives are probably more familiar to the reader than any other couple we could have selected.

Because he signed so few signatures and because of his enormous popularity, Kennedy's signature has become the rarest of any President's. Jacqueline Kennedy's page used here has the distinction of being the most valued letter of a living person ever sold in public auction. It brought $3,000.

The narrative reports of the Kennedys which follow represent our attempt to explore unknown facts concerning them. Our primary purpose is to show the reader how two handwritings delineate the personalities of the writers.

J. F. K.'s handwriting. John F. Kennedy had the most variable and extraordinary handwriting and signatures of any President of the United States. As you look at his free-flowing, spontaneous script, which is reduced to less than its normal size, you need not be a graphologist to "get the feel" of his personality, even if you can't read all the words of his message. But, of course, the reason you can't decipher every letter is that he thought so much faster than he could write.

This flexibility of movement combined with his boldly dashing strokes depicts the exploratory flights of his imaginative mind and the restless impatience of his strong emotional nature. In contrast, the modulated gradations between his thick and thin strokes reveal a dynamic and courageous leader capable of tender and sensitive responses.

The long arched t-crossings which form a roof over the following letters are a manifestation of his need for direct and forthright confrontation with established values and conventional attitudes. The impetuous intensity of his uphill drive shows the conviction with which he fought the forces of gravity and

THE WHITE HOUSE

WASHINGTON

J.F.K.'s handwriting, says author, reveals "exploratory flights of his imaginative mind and the restless impatience of his emotional nature." It also depicts "a dynamic and courageous leader capable of sensitive responses." Courtesy of Charles Hamilton, from "The Robot That Helped to Make a President."

oppressive pain while maintaining enthusiasm and hope for the future. His decreasing left and right margins betray a man of restraint and caution who expanded in strength and total commitment the deeper he explored any subject or locked horns with the environment.

The smaller size of his signature as compared to the rest of the note is an index to his true modesty and humility, which few persons knew or understood. It is also one of the rare clues to his frequent inferiority feelings which only his wife or his closest friends could have ever suspected. Being able to conceptualize the enormity of the problems facing him as contrasted to his inability to solve all of them, he lived in a constant state of psychological frustration, which only his vast spiritual sensibilities could help him resolve.

The broad spaces between his words and lines—the total amount of white space left uncovered on the page—is a graphic token of the respect he maintained for the thoughts and feelings of others. He was a leader, not a dictator.

His soft and tender-hearted proclivities are found in the rounded, undulating forms which rest on the base line in his s i g n a t u r e and throughout his writing.

A wry wit and an ironic sense of humor are deduced from the overall designs of his letters and connections. His inattention to details, and at times his outright sloppiness, was due more to his global approach to life than to any carelessness. He finally gets his i's dotted, but he does so at the end of the word. He just can't waste the valuable time to travel back over ground he has already covered. He was more intuitivist than logician.

On the Graphological Psychogram, John F. Kennedy gets a rating of 100 percent for functional productivity and 100 percent for intellectual and cultural proclivities. These scores show him to have been as intellectually fertile as Jefferson or Lincoln and as progressively functional as the Roosevelts.

His lack of pretentiousness, shown in the natural designs of his letters, is proof that this man of great wealth and breeding had a birthright "instinct" for the problems of the common man.

Jackie's handwriting. In the art of handwriting analysis, the piece of paper becomes the canvas on which the writer paints her self portrait. Jacqueline Bouvier Kennedy's pictorial and artistic handwriting expresses her dramatically visual orientation to the world in which she lives. Her critical and analytical mind is most receptive to perceptions of form, design and color. All the graphic elements of her self portrait harmonize with the landscape of her life. She even frames the picture of her script with intuitive decision and definite balance. She is an aesthetically and culturally motivated woman whose handwriting depicts her as a person of infinite discretion and gracious charm.

I pray that things will work out for yw - as I said - I would have helped yw if I could - I hate to put an end to your dream - but I think yw were looking for a miracle that just wasn't happen in the twentieth century -

May yw and your family stay as happy as yw are with each other - and I am sure God will be kind to yw

Very Sincerely
Jacqueline Kennedy

Courtesy, Charles Hamilton

Mrs. Kennedy's handwriting shows "her cosmopolitan heritage and breeding," says the author. It also uncovers keen wit, a strong mind. Her words are more legible than J.F.K.'s, but they deviate more from copybook norm. Her calligraphy "demonstrates the versatility of her cultural individuality."

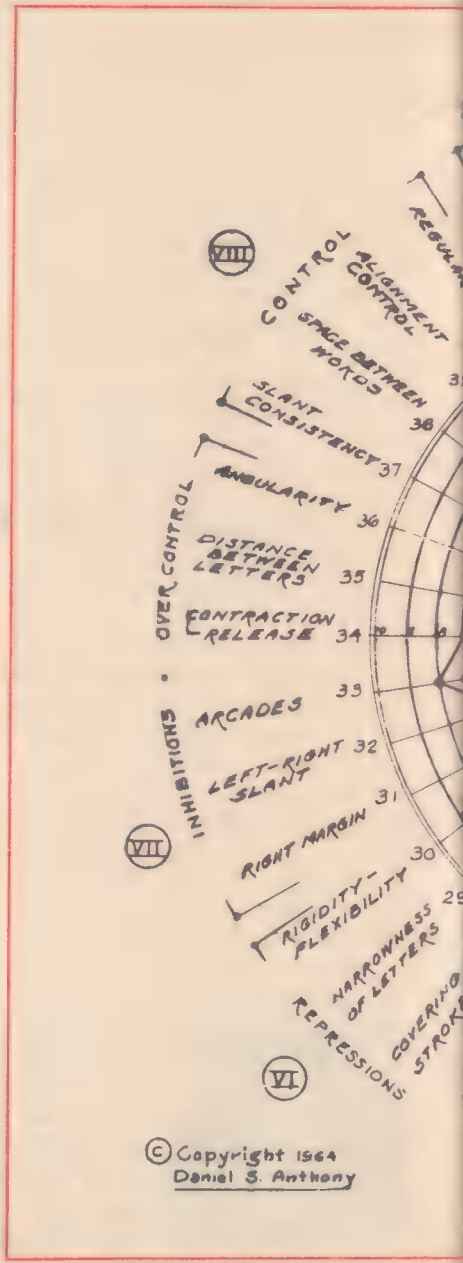
With these as the major hallmarks of her introspective personality, she could dislike nothing more than her continuous exposure to the public. With apologies to her delicate sensitivities, I can say that very few strokes of her pen betray any psychological "skeletons in the closet" which will prove inimical to her own best interests.

The imaginative and aesthetic designs of her writing are reproduced graphically by the balanced proportions of black and white. These harmonies attest to the equilibrium of her spirit, mind and body. Her general conceptions are ingeniously corroborated by her spacious pictographic signature, the softly rounded loops of her f's, h's and k's.

Her differentiated life style is further characterized by the polished liberties she takes in inventing her personalized letter forms. The rightward swing of many of her loops which also reach high into the upper regions symbolize her public image. They show the outward and extroverted dynamics of this essentially introverted and philosophical nature. The unselfconscious and even carefree ease with which she articulates her small letters is an indication of her social sophistication and her spontaneous

Kennedys compared

J.F.K.'s and Jackie's writing is rated from 1 to 10 in this psychogram—his in thick line, hers in thin. General personality characteristics, outer circle, are indicated by features of handwriting, 1 to 40.



REVISION 1964
OF
ROMAN-STAEMPFLI 1955
PSYCHOGRAM

freedom of association.

Mrs. Kennedy's great deviations from the copybook styles of the Western world are the positive signs of her cosmopolitan heritage and breeding. Her cultivated speech and her continental finesse are graphically depicted in her backward slant as well as in the decorous spacing between her words and lines of writing. This same backhand slope, combined with her ingeniously sculptured personal pronoun "I," are symbolic of a remarkably keen-witted and strong-minded thinker.

Certainly the lyric, almost dulcet tones of her subdued T.V. voice would not have given any intimation of her hard-headed economics and practical abilities in running the White House and controlling her own destiny.

With almost a revolutionary defiance, she has tailored her own calligraphic fashion to suit her taste and to demonstrate the versatility of her cultural individuality. While her words are, on the whole, more legible than those of her husband, they deviate more from the norm than his do.

Her superego portrays a strong moral-ethical value structure which guides her conscience in controlling her emotional life. Her ego is virtually more dominated than dominating. She is not an egotist.

Probably her most unusual graphic habit is the simplifying or shortening of many lower case letters. This contrast of upper zonal elaborations with lower zone and middle zone reductions signifies a person who has practically renounced egocentric material and monetary values in favor of the more lasting joys of spiritual contemplation and aesthetic gratification.

The d i a g o n a l connecting upstrokes which run from her t's through her h's, the three-dimensional movements and designs of her f's, show an originality of organization and integration that is usually found only in creative artists and professional writers.

The scientific aspect. What is the scientific promise of graphology? Judging from the strides made on the continent of Europe in the past 50 years, we in this country are lagging behind. There are several reasons for this.

At present, here in our educationally progressive and dynamic country, only one institute of higher learning, The New School for Social Research in New York City, offers courses where an inquiring mind can be exposed to modern handwriting analysis.

More than 35 years ago, Dr. Gordon W. Allport, professor of psychology at Harvard, opened the door to future generations of graphology investigators with his *Studies in Expressive Movement*. Relatively few scientists have since followed his lead. In 1964, Dr. Allport went so far as to invite this author to give seminars on graphology to his classes at Harvard with the hope that, in his words, "we can excite a few of these students to undertake

One college teaches graphology; psychologists wish there were more.

future research of merit in the field."

Dr. Rudolf Arnheim, professor of psychology at Sarah Lawrence College, also teaches courses in "Basic Problems in Psychology" at The New School for Social Research. He spends several sessions exposing his classes to the untapped potential of handwriting as a projection of the personality. This author teaches five semester courses at The New School, and several of Dr. Arnheim's students are getting a start in this "brave new world" of personality interpretation.

Since no universities offer graphology in their graduate psychology departments, and because there has never been a state licensing examination for the practice of graphology in this country, literally thousands of untrained individuals are presuming to practice this complex science. These rank amateurs have taken a few correspondence courses which purportedly "qualify" them as "graphoanalysts." They hang up their shingles and offer a specious brand of occult "handwriting analysis."

There are five major complaints about graphology. They are:

1. Since every person is taught to duplicate a copybook model, no one is ever free to write in accordance with his own personality demands: Writing is a conditioned reflex.

Obviously this argument falls apart because no one but penmanship teachers and a few accountants maintain the letter perfect forms of the copybook s t a n d a r d s. Most grammar school graduates have already developed their own styles and deviations. They will never again return to the standard in writing.

2. Graphologists are like fortune tellers; they are smart intuitivists who judge the personality from one's speech and actions and draw their graphological deductions from the contents of the message or written sample.

True, many of the fakers do, but the professional graphologist seldom sees the subject. He does not want to be influenced. He analyzes only the traces of movement and the spaces on the page. He has learned through experience that reliance on contents is usually more damaging than helpful to his accuracy. So the content or the wisdom or ignorance of the specimen is not considered.

3. Because of the easy availability of anyone's writing, the unprofessional person can do a lot of harm with his gross invasion of an individual's privacy.

This is a legitimate complaint. The trained graphologist, however, follows the ethics of the medical and legal professions. He analyzes only those handwritings he has been commissioned to investigate. He maintains the confidential relationship of a doctor with his patient.

4. Handwritings can be readily obtained by employers and used against the employee.

I have no ready answer to this objection except to say that most employers also procure credit reports, and they have the applicant examined by the company physician.

5. No great psychologists or doctors have ever become graphologists.

Not true. In the past five years, at least 20 physicians, graduate psychologists, sociologists, lawyers and scientists have taken courses in this subject. In the 28 years I have been practicing graphology, I have yet to meet the skeptical physician, psychologist, sociologist or scientist who, after a one-semester exposure to graphology, was not totally convinced of its superior potential as a psycho-diagnostic aid to the improvement of man's mental health and his relationships with his fel-

Despite the unethical exploitation of graphology, and despite our academic indifference to the positive potential of serious handwriting analysis, hard-headed American business executives, constantly in search of success-motivated employees, have found this technique a boon to their personnel selection procedures. One life insurance agency manager says: "From your evaluations we learn how a man will react to rebuffs and fight adversity."

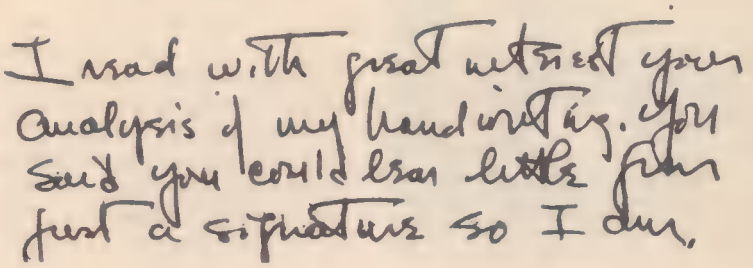
It is my prediction that the few serious students of graphology in this country will be making significant breakthroughs in the foreseeable future on a variety of frontiers. There are indications that some scientists are at last beginning to heed the advice of Dr. Sigmund Freud who said: "There is no doubt that men express their character through their handwriting."

Dr. Kenneth Wade Thompson, research director of Organon, Inc., of West Orange, New Jersey, in a letter published in the October, 1965, issue of the *Journal of the American Medical Association,* said: "It is a pity that graphology is so neglected a science. Surely, with time and dedicated study its value will be recognized. The handwriting provides an enduring sample of not only the writer's message but also his graphic projections, frozen as it were in time. The physician should know more about what handwriting reveals of the writer." As a neuro-surgeon and graphologist, Dr. Thompson is now preparing a definitive comparison of the relative advantages of graphology and other psycho-diagnostic techniques.

Graphology will also take a great stride forward when M.I.T. completes its original research on pattern recognition and the replication of handwriting by the computer process. We shall then understand more about the human brain and why handwriting is brainwriting.

It is possible, too, that I.B.M.'s research can teach its biggest computer brains how to interpret and then program the measurable graphic variables. Hundreds of graphic variables will then become available to computer programming and measurement.

What your handwriting shows



Everybody's handwriting can be analyzed to good purpose. Here is a sample of writing by an applicant for a job as a life insurance salesman. It is worth noting that the man's handwriting, necessarily reduced here, is actually three times as big as it appears.

LIFE insurance agency managers succeed or fail on their ability to pick good salesmen and reject poor ones. But even with the knowledge that the selection of winners is the backbone of their business, they still have an agency turnover of 70 percent or more in three years' time. The Life Insurance Agency Managers Association in Hartford, Conn., employs scores of trained psychologists who have been trying for years to devise tests and interviewing procedures which will prevent this inordinate loss of manpower, money and time spent in training. While they have refined their old techniques considerably, most agency managers spend most of their time playing nursemaid to salesmen they shouldn't have hired in the first place.

Twenty-five of these perplexed life insurance agency managers have turned to graphology in an effort to reduce their great rate of turnover. They have learned that an evaluation is insurance against costly losses.

Here is a typical evaluation of the handwriting (above) of an applicant for life insurance salesman:

Philip Moss, age 40, right-handed

Despite this man's relatively advanced age in choosing the new and difficult future of a career life insurance salesman, I find that he can become a superior life agent in a minimum training period.

Whether or not he will become a member of the Million Dollar Round Table in his first three years will depend upon how your training supervisors heed the advice contained in this evaluation. Here is the way I see his assets and liabilities functioning for you:

Ambition — 97% or AA+. He is a driving and a driven man. His own self starter is better than any stimulants you can give him. His goals are so high that his vision of his own success is more glorious than any rewards you can dangle before him.

Competitive nature — 94% or A+. He shows a built-in need to win. He has to dominate most situations, but he also has the taste, tact and discretion to keep his mouth shut while the client is talking. The natural fighter's instinct and the big sale psychology are strong components of his competitive drive. He has rare guts.

Persuasiveness and enthusiasm — 95% or A+. He exudes confidence. His sympathetic interest in others makes him a specialist in understanding of knotty insurance problems. His uncanny aptitude for sizing up people and communicating abstract, intangible ideas is the bedrock of his superior sales ability. Being a self starter, he faces each day's new situations with energy and excitement.

Emotional stability — 92% or A+. This man has too much ego dynamics to function as a regular trainee and team member. He is volatile individualist. He is so quick-thinking and he acts and sells so dramatically, he will leave the rest of the learners at the starting post. Therefore, don't mix him with the rest of your ordinary recruits; he will be a disturbing influence. Give him isolation training as an independent producer and let him go his own way after he gets the essentials of your product.

Creativity and spontaneity — 98% or AA+. Since he operates in such a unique idea stratosphere, I cannot recommend him for a place in your recruit training program. His personality will prove inimical to your team interests because of his bizarre imagination, resourcefulness and originality of thinking. His gargantuan desires and ego drives will be so "way out", they will not prove a model to the rest of your men. He will even buck you in the presence of your men, if he disagrees with you. He has too much responsibility and integrity to put diplomacy above honesty. He bounces back after a rebuff with wit and wisdom, but he shows the tenacity of a bulldog in prospecting for business and getting the signature on the dotted line.

Recommendation. He is much too rich for your agency's blood. Don't accept him unless you can assign your top trainer to him as an individual tutor. If you can afford him this training luxury, you will have a life insurance producer who will sell more within one year's time than any other three men I have evaluated for you this past year.

He is such a rare find, unfortunately he will require unique treatment. But don't you worry about competition from him. He wouldn't last as a manager for two weeks. He hates the details of administration and could never stick to the rigid disciplines of the home office dictates. Besides, he's too much of a general to be interested in commanding a mere platoon.

Admittedly I make him sound a bit overwhelming . . . but it's only because he is!

As visualized by one space firm, astronauts study Phobos, a moon of Mars, before continuing on to the mother planet behind it.

Martin Co.

For sale: men to Mars

by Bruce Frisch

BRACE yourselves to be sold the highest priced package in history. The cost to you could top $100 billion for a series of increasingly complicated space ventures climaxed by a manned landing on Mars.

Recently, the low-pressure campaign for this plan that has been going on for several years rose a noticeable notch in intensity. The reason was that nothing beyond the Apollo man-on-the-moon project has been okayed, and the Apollo pipeline is beginning to go dry.

A project pipeline is several years long, with planning at the start, research, design and development in the middle and hardware and launch at the finish.

Last summer, National Aeronautics and Space Administration chief James Webb told a Congressional space committee that in six months the planners and designers of Saturn V and Apollo would be out of work unless they got a go-ahead on new programs. Later, in the fall, another NASA official, Dr. Robert Seamans, Jr., warned that our space capability developed for Apollo "cannot be mothballed. . . . We must use it or see its value erode." Put another way, NASA and the aerospace industry could waste away from money malnutrition.

What NASA has in mind is a four-stage extension of *man* into space. Immediately after the Apollo landing, an Apollo Applications program of lunar exploration would begin, using mostly equipment based on Apollo hardware. Next would come a post-Apollo applications

Estimates for a trip to Mars ticket go from $10 to $100 billion

phase, with longer trips on the moon, and longer stays perhaps leading to a permanent base on the moon. A Manned Orbiting Laboratory (MOL) would be the third stepping-stone. Experiments carried out in MOL would prepare the way for the final stage of the plan, manned flight to Mars and Venus.

At first, astronauts would fly by Mars and Venus. Later, about 1983, they would land on Mars for the grand finale.

How much would it cost? Just on the most expensive part, the trip to Mars, estimates have ranged from "little more than $10 billion" (from a booster) to "perhaps $100 billion" (from a critic). Inside NASA, the spread goes from $20 billion, about the cost of Apollo, to "the same percentage of the Gross National Product as Apollo," thus several times the cost of Apollo, to "many times the cost of Apollo."

In any case, a trip to Mars will be a target for criticism as loud or louder than directed at the moon program. In its defense, NASA will be able to wave two reports from scientists. University and government scientists who were invited by the National Academy of Sciences to a meeting for NASA last summer recommended an Apollo Applications program running to 1974 and a post-Apollo Applications project extending to 1979.

Earlier, the space sciences board of the academy endorsed a complete four-stage program. However, it put Mars at the top of its list, saying the lunar program should be "subordinated" to it and MOL should be a "secondary" goal. The study of Mars, said the council, "could lead to an understanding of the origin of terrestial life," and would free us from having to judge the laws of planetary formation and evolution from one example, earth.

Old arguments

Nevertheless, many of the same arguments used against Apollo will probably be revived. For instance, scientists such as Dr. Vannevar Bush, World War II head of the Office of Scientific Research and Development, and Dr. Philip Abelson, editor of the journal, *Science,* of the American Association for the Advancement of Science, have claimed that unmanned vehicles could do almost as much scientific investigation as a man at about one percent of the price. The National Academy of Sciences space sciences board, on the other hand, argues that "the ultimate scientific exploration of Mars will require that man be present." By implication, at least, they feel his presence is worth the extra cost.

Again, most likely, many will argue that the difference in cost could better be spent on earthbound

social and health improvements. But as with Apollo, it is unlikely that money not shot into space would be appropriated for such ends.

In answer to these criticisms, we will probably again hear familiar arguments in favor of manned space flight. One that NASA has taken particular pains to publicize is that from space research and development there is a spinoff of new devices and knowledge into the civilian economy. Hoping to back up its claims with facts, NASA sponsored a study by the U. of Denver Research Institute. The institute found that "the specific needs of a missile or space program are often quite different from the specific needs of industrial or consumer markets." On top of this, most aerospace companies were found to have little commercial experience, so either didn't recognize possibilities or didn't want to bother. The outcome was that indirect civilian application of new knowledge was much more important than the direct use of devices. Even then, the institute found that examples of such "intangible spinoff" "are difficult to identify" and "frequently they are undramatic and obscure." One conclusion: "Spinoff should not be used to justify large space and defense expenditures."

If reasoning fails to persuade us, we will be asked to react emotionally as we did to the idea of beating the Russians to the moon. Perhaps the prod will be something like the one pulled out this fall by a NASA official looking forward to manned exploration of the planets and beyond. He said, "Historically, a nation has never been dynamic unless it accepted the challenges it could accept."

Money woes

Out of all the arguments, the most forcible for NASA at the beginning of 1965 seemed to be economic. The aerospace industry was in trouble. Back in the early and mid-50s, most aerospace sales had been from the production of aircraft. Starting in 1957, there was a shift to missile production with a resultant movement of the industry from the Midwest to the coasts, especially California. When a space boom coincided with missile-stocking, aerospace industry expansion took off. In 1964, it looked like the industry was overexpanded. That was the year our silos became full and missile production fell off. Then there was a peace scare. The Russians had been friendly and Arthur Barber, Deputy Assistant Secretary of Defense for Arms Control, said they were also in an economic squeeze. An arms control agreement was a better than even chance in 1964, he said, so the defense industry should look for other business.

Oceanography a favorite

Aerospace people did. Oceanography was a particular favorite. The industry has also been enthusiastic

about trying to apply the methods it used to attack space problems to remedying the ills of society. But the Arthur D. Little consulting company found in a survey of the aerospace industry's prospects that attempts to diversify into nonaerospace "have almost always been marked failures." The future would be worse, the survey went on, predicting a 15 percent further drop in government aerospace spending by 1970.

The year 1965 opened with widespread warnings of a second year of decline, setting the stage for NASA worries about lost jobs and eroded capabilities. Vietnam ruined the script. Down went chances for arms control. Up went orders for aircraft. Instead of shrinking, the aerospace industry grew even bigger.

More serious for space plans, Vietnam took money. When government departments in November submitted to the White House and the Budget Bureau their budget requests for the fiscal year starting next July, the hatchet was out for the civilian portion. At the same time, it was reported, President Johnson wanted to be tender to his Great Society programs. One thing remaining to be chopped was space.

Over at NASA, Apollo Applications officials asked the upper echelons for $700 million to start them on their way. The request was slashed. Despite such paring, NASA asked the President for $5.6 billion, $400 million over this fiscal year's budget. Instead of getting its hike, NASA appears to have taken a cut to a flat $5.0 billion.

Man-to-Mars has suffered a setback at the start. This could have the effect of adding a note of urgency to space agency salesmanship, because although the aerospace industry is not now in trouble, NASA is.

"He's Found Judge Crater!"

Goodbye to infection

Our systems defeat infectious diseases with antibodies. Experts now forsee laboratory-made antibodies.

by Walter Sullivan

SEVERAL of those in the forefront of research into antibodies, the chemicals with which our bodies fight infection, believe an understanding of how they are formed may be imminent.

Some even predict the manufacture of antibodies in the laboratory, a development that could revolutionize medicine. Few are the diseases whose course, in the long run, is not determined by antibodies.

Infectious diseases

The infectious diseases, from head colds to smallpox, are cured or prevented by antibodies. Other diseases, including those involving allergies, rheumatic fever and possibly arthritis, occur when the individual's army of antibodies misbehaves.

The same army stands in the way of widespread organ transplantation. It rejects as foreign invaders those organs provided by other individuals.

The optimistic statements concerning the production of antibodies are probably comparable to the first sighting of a distant summit by mountaineers. Thus, the goal is far more distant than it seems.

One of the optimists is Dr. William J. Dreyer of the California Institute of Technology, who recently predicted that it may ultimately be possible to synthesize antibodies to fight new diseases. He has helped develop a new theory to explain the enormous diversity of antibodies.

However, in a recent press briefing on advances in this field, one researcher noted that the body probably produces a million or more different kinds of antibody molecules.

For manufacturers to compete with the body in this respect would be a formidable task. For example, there appear to be hundreds of different viruses causing the symptoms that we call a cold. The body produces antibodies to rid itself of one kind, only to fall victim to another a few days later.

If it were possible to determine the guilty virus quickly, and pick the correct antibody from a druggist's shelf and inject it, it should be possible to terminate a cold almost immediately. This, however, seems a very distant prospect.

Antibodies are complex protein molecules designed to react exclusively in connection with some protein that is foreign to the body. It is the body's ability to manufacture an almost unlimited variety of these molecules that enables it to fight off a great number of diseases.

The antibodies must be so discriminating that they do not hitch onto the proteins of a person's own body. The proteins consist of extremely long chains of amino acids. There are only 20 varieties of amino acid in the proteins, but their sequence is almost infinitely variable.

Protein differences

Hence, apart from identical twins, the proteins of every person differ slightly from those of everyone else. Even a skin graft obtained from a close relative is recognized by the body as foreign and is attacked by its antibodies.

Sometimes antibodies will work against more than one kind of invader. A century and a half ago it was discovered that the virus from cowpox, a cattle disease normally harmless to people, stimulated the body to produce antibodies that were also effective against the dread smallpox.

In the vaccine developed by Dr. Jonas Salk, molecules in the polio virus were treated with formaldehyde, "killing" the virus by altering those amino acids in its structure that caused infection. However, those amino acids stimulating the production of antibodies were apparently unaffected. Dr. Albert B. Sabin was able to alter live polio virus so that, although noninfectious, it produced antibodies effective against the disease.

Dr. William Dryer believes that a single gene controls part of every antibody.

The antibodies are contained in that fraction of the blood plasma known as gamma globulin. This fraction has defied chemical analysis because its molecules are so highly diversified.

One of the paradoxes in this field of research has been that the human egg cell, with its limited archive of genetic information, can generate all the complexity of the human

body and, at the same time, produce a million or more varieties of antibody.

Some believe the antibodies are not inherited, in any way, but are custom-made for each invader. In this view, the antibody shapes itself to match and neutralize the invading protein. This view, according to a number of experts, has largely been abandoned in part because resistance and vulnerability to disease seem to be inherited.

A break in the attempt to explore the antibodies has come with study of a peculiar protein found in the urine of those with multiple myeloma. In that disease, the plasma cells that produce antibodies become cancerous. The 19th-century British physician Henry Bence Jones identified this protein, which now bears his name.

Bence-Jones protein

It turns out that the Bence-Jones protein constitutes a key portion of the antibody molecule.

Hitherto, the make-up of the antibody molecule had defied analysis. The blood contains such an enormous variety of such molecules that it had been impossible to weed out any one of them for analysis.

The antibody molecule is now thought to consist of four chains of amino acids, each folded so that its components fit together chemically.

Two of the chains are "heavy" in that they consist of identical sequences of 400 amino acids. The other two "light" chains consist of identical strings of about 210 amino acids. These four chains, in the complete antibody molecule, are held together chemically (by bonds between sulfur atoms) to form "slots" at the two ends that latch onto one or more forms of invading protein.

Proper key

The slots can be likened to a lock that will react to only one key.

The Bence-Jones protein, it turns out, constitutes the "light" chain from one of the antibody molecules in the diseased individual. All of this protein recovered from the urine of a single case of myeloma is identical, thus furnishing enough of the substance so that the material can be analyzed.

This is done by chewing down the molecules with enzymes and by other means to determine their amino acid sequence.

In the study of Bence-Jones proteins from both human beings and mice, it has been found that, while part of the amino acid chain differs from individual to individual, roughly half the chain is identical with corresponding portions of all other Bence-Jones protein chains. The half that varies is obviously analogous to the tumblers in a lock that respond to only one key design.

It appears that this pattern applies to both the "light" and "heavy" chains of all antibody molecules. The molecules thus consist of uniform portions, common

to them all, plus active areas at each end.

An easy explanation for the multiplicity of antibodies is that a million of them are produced by a million genes, or units of heredity. passed from one generation to the next. This does not seem to be the case because, by altering a single gene, it is possible, in a given individual, to alter the portion of the molecule common to all his antibodies.

Million factories

If there were a million factories producing automobiles, it is inconceivable that damage to one item could alter the design of all cars. Hence, Dr. Dreyer and Dr. J. Claude Bennett have suggested that the portion of each antibody that is common to them all is controlled by a single gene. The remainder is produced by a host of other genes.

It is as though one factory turned out identical automobile chassis by the million and other plants added something that made each one different. That is, another gene—one of thousands or millions performing such a task—hangs its particular pattern of amino acids on the chassis.

"Oh, no - after you!"

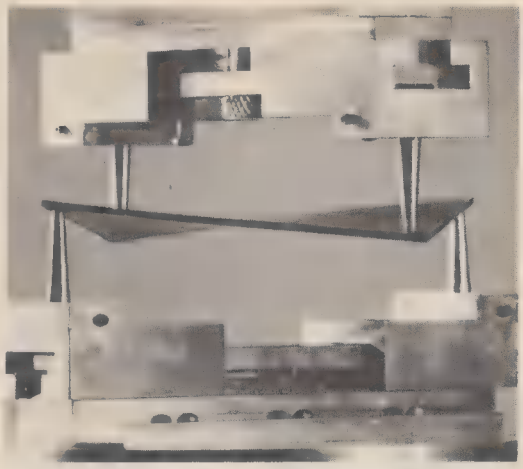
Single strand

A great many of these variant genes ride a single strand of the nucleic acid that provides for heredity. In each case the structure of the resulting antibody is determined by which part of the strand puts its imprint on the chassis—a random process that would help account for the enormous diversity of the resulting antibodies.

Such a genetic procedure, according to Dr. Dreyer and Dr. Bennett, is "radically different from anything normally found in modern molecular genetics."

It occurs, presumably, as the body's immunity system matures. Only a single antibody of any one kind need be made at this stage. It then lies dormant in the plasma cell until infection confronts it with the invading protein against which it is active. This then stimulates the proliferation of that particular antibody.

Dr. Dreyer believes that antibody structure and synthesis may ultimately be well enough understood so that, in such a situation, man in the laboratory could manufacture his own defenders long before his body could do so.



Flexing machine exerts powerful opposing forces on tough, new boron composite, but it withstands the test.

The material that will revolutionize construction

WHAT earthly good is our race in space doing for us? Answer: Very often, what we learn while we develop new space technology leads to dramatic, down-to-earth improvements in daily life. From launching site to living room, from intergalactic to interurban, can be a very short trip.

The communications satellites Telstar and Early Bird make good examples. Techniques developed as part of space science have brought these stunning accomplishments into our domestic lives, to give us glimpses of the communications systems that will be available to us in the near future.

There are many other examples, of course; and now another looms.

Texaco Experiment Incorporated (TEI), a Texaco aerospace subsidiary in Richmond, Virginia, is the organization directly involved. Under an Air Force contract, TEI is supplying the key component for an entirely new structural material that, according to one Air Force General, puts this country "on the

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Boron was first produced as a continuous fibre by Texaco Experiment, Inc. Air Force officials are interested in the revolutionary material for heat resistant rockets.

threshhold of the greatest single advance in materials in the last 3,000 years."

The material is a composite of boron filament set in a metal or plastic matrix. It excites spacemen because among the most important considerations that determine the use of construction material in aeronautics are weight, strength, stiffness, and melting point—and on all these counts, the boron composite outpoints by a very wide margin any other available material.

First, it is extraordinarily light: 15 percent lighter than aluminum. It is six times stronger than aluminum, and six times stiffer (stiffness is an extremely important consideration in aircraft construction). Its melting point is more than three times higher than aluminum's, and that makes it interesting to designers of supersonic aircraft. Finally, boron is extremely hard; it is next to diamond on the hardness scale.

It was in TEI laboratories that pure boron crystals, and later boron fibres and filament, were first produced. With these two accomplishments, boron became workable as a structural material. Until then, and despite the fact that it has been recognized as an element for more than 150 years, no practical use for boron had ever been found.

Actually, investigations with a quite different goal led to the new role for boron.

When scientists first became interested in the element, it was as a component in high-energy fuels. As far back as 1950, TEI was at work with the Air Force and other agencies, intensively studying boron for this use.

While they were carrying out research to find how best to use the unusually high thermal energy contained in boron, scientists learned to produce samples of elemental boron of increasing purity. Once they had samples of purified boron, the investigators began noticing properties that made the element promising as a structural material. Now the Air Force, while it still is interested in boron as a fuel component, is equally interested in boron monofilament (a single, untwisted filament) for use as an ultra-property structural material.

Bridges of boron

Americans can look forward to a long list of non-military uses for the material. Some of them could begin to appear surprisingly soon.

Bridges of boron composite, for instance, could span twice the distance possible with structural steel. The new Verrazano bridge in New York City now is the world's longest. It stretches a breath-taking 4,260 feet. One hundred and sixty thousand tons of structural steel went into it. Made of boron composite, its span could be double—and the weight of the boron composite would be just 93,000 tons. The bridge of boron would be just as safe, and could handle just as much traffic, as the Verrazano does now.

The world's tallest building is the Empire State Building, as nearly every schoolboy knows. It is 1,472 feet from sidewalk to antenna tip. By the time our current crop of schoolboys is adult, it may be feasible to erect skyscrapers five times taller, using boron composite as the structural material.

Surface transportation

It is reasonable to expect that boron composites will play a role in the improvement of both old and new forms of surface transportation. Already, designers are talking seriously about air-cushion trains that would fly at 300 miles an hour over standard-gauge railroad tracks. These would be lifted by compressed air. Obviously, weight of the trains would be a critical consideration, and until now aluminum has been the most likely structural material for them. But if they were built of boron composites only half as much levitation power would be needed and operating fuel costs would be substantially reduced.

Hydrofoil ships already are in scheduled commercial use. They, like airplanes and air-cushion trains, are payload-limited. Each pound of hull or structural weight eliminated means that another pound of payload can be carried. Using boron, it might be possible to reduce the weight of these craft by about 40 percent.

On the highway

Even highway trucks stand to benefit from boron. Right now, truckers find themselves in trouble on some stretches of highway be-

cause of load limits. If their carriers were built at least partly of boron composites (stronger than steel, twice as stiff, and three-and-a-half times lighter), more pay weight could be hauled without exceeding highway load limits.

The petroleum industry could save perhaps 40 percent in the cost of moving its portable drilling rigs, if the weight of those rigs were reduced without a loss in strength through the use of structural boron composites. The cost of setting up certain rigs could be reduced by about a third. The time needed to draw 20,000 feet of drill stem out of a well, replace a drill bit, and put bit and stem downhole again could be cut by 15 percent if these components were made of boron composites.

Drilling platforms

Some of the transportable offshore drilling platforms in use today are very large. One, in the North Sea, is about as tall as a 16-story building. If this rig were constructed of boron composite instead of structural steel, its weight would be reduced 82 percent.

Just how soon the use of boron composites will become practical depends, to a large degree, on how soon boron becomes economic for industrial and civilian use.

Right now, boron filament is quite expensive. Almost every new material is, in its early stages of development. Aluminum certainly was: at one time, jewelers offered opera glasses in either platinum or aluminum frames at the same price. Napoleon III served his more distinguished dinner guests from aluminum dishes, while lesser guests got along on gold plate.

Cleanser base

Borax, the mineral from which boron is produced, is not at all expensive. There is plenty of it in the desert area of California, and it has been mined there inexpensively for years. It is used in soaps and cleansers. It is the same borax those celebrated 20-mule teams used to haul.

The current work with boron derives, conceptually, from much earlier work with glass fibres.

Scientists who work with materials know that in a block of glass or steel the bond between atoms is immensely powerful—theoretically something more than a million pounds per square inch. But glass and steel do not have this remarkable strength in actual use. It is impracticable to manufacture them with absolute uniformity of structure, entirely free of imperfections. And it is around imperfections that stresses accumulate. The cracks opened up by external stress spread,

and a fracture results.

The theoretical strength of certain materials has been approximated in "whiskers" of the materials, which are elongated single crystals produced under controls that minimize imperfections. But in any piece of material massive enough to do a structural job, flaws cut the realizable strength to a fraction of the theoretical.

Two-phase materials, like fibre glass and the boron-resin composite, capitalize on the fact that under force the resin matrix stretches and deforms. When it does, it distributes stress to the high-strength fibres. The total structure then absorbs a loading stress that would easily rupture the weaker component. At the same time, the isolation of the imperfections in the individual fibres prevents the spreading of cracks from these imperfections.

In nature, wood uses the two-phase concept. Bamboo, for example, has long, high-strength fibres arranged lengthwise in parallel, which are extremely strong. Between these fibres is a natural matrix of the spongy substance called lignin.

The result is a material with great resistance to scratches and bruises, and a handy lightness. A fly rod of bamboo may weigh as little as two ounces, yet be sufficiently resilient and strong enough to land a very resentful two-pound trout.

The whole story of boron composite materials cannot be written yet, partly because much of it is highly classified and partly because what has been accomplished so far really represents just the earliest chapters.

But even in the early stages, it seems clear that alert research could lead to heroic forward steps in this nation's technology before many years have passed.

"I shed, too, but with you it's something different."

Lessons for everybody from jet travel fatigue

by Stanley L. Englebardt

WHEN the airlines invite you to "come on down" these days, they never mention that a mighty tired pilot may be at the controls. Fatigue—dog-tired, bone-weary fatigue— is one of the very real problems of the jet age. It hits pilots, co-pilots and stewardesses alike. It may even bother frequent jet travelers. It is so prevalent, and so potentially dangerous, that both the government and the airlines are spending millions to see what can be done about it.

The various studies underway today are by no means conclusive or

completed. Nevertheless, findings to date have been dramatic. Not only have researchers uncovered several major causes of jet crew fatigue, but they've provided insight into why some of us in more mundane pursuits suddenly develop that midday letdown.

In the old days

Flight fatigue is not a new problem. Even in the relatively slow-moving days of the DC-3, pilots complained of uncommon weariness. As a result, regulations were established limiting the number of hours an air crew could put in each month.

The advent of jet transports has intensified these problems—and added new ones of its own. According to a study by Dr. Gerard Juin, jet crews experience much more fatigue than piston-plane crews doing approximately the same work over the same period of time. Furthermore, recuperation from this fatigue is slower and less complete.

What causes this fatigue and what can we on the ground learn from it?

There are many factors involved in fatigue—some of them peculiar only to jet crews. One unique air crew problem is disturbance of the "metabolic" or "biological clock"—that innate timing mechanism in all of us that tells when to wake up, when to eat, when to retire and so forth. Dr. Juin found that this clock becomes disrupted when we cross more than four time zones, a fairly common practice among crews of long-distance jet planes. Somehow, time-shifts lower the physical and intellectual levels of people experiencing them. And it may take anywhere from three days to a week for an individual to recover from them.

Other fatigue-producing factors experienced primarily by jet crews involve visual problems caused by solar radiation, space myopia (inability to focus because of loss of background reference points), and low oxygen intake. Also, there is evidence that glaucoma—a serious eye disease—may be prematurely induced among jet pilots as the result of lowered atmospheric pressures. This finding, however, is not definitive and is now undergoing additional investigation.

Jet crews

All of this contributes to the fatigue of jet crews. For the most part, though, they get tired for the same reasons we do—only the factors are accentuated in an aircraft. Take noise as an example. According to the *Flight Surgeon's Manual:* "Of the more general effects of noise, the most universal is feeling excessive fatigue at the end of exposure. This fatigue is out of all proportion to the fatigue which could be expected from similar work under more quiet circumstances."

Noise levels in an aircraft, even the supposedly quiet jets, are particularly high, somewhere in the area of 100 decibels. Yet even con-

siderably less noise can have a detrimental effect. An experiment in 1960 by a Russian scientist indicated that noise of 85-decibel intensity upset the conditioned reflexes of white rats. Other investigations support this finding, and even point to additional effects such as disturbance of the endocrine, nervous and cardiovascular systems.

Vibrations

What we call "noise" is, in effect, a non-harmonious grouping of frequencies or wave lengths. When these wave lengths drop below a certain point we stop calling them "noise" and start calling them "vibrations." And this is another major cause of jet crew fatigue.

It's been demonstrated many times that vibrations of certain intensities can kill animals. With this in mind, there's no doubt that humans subjected to long hours of vibration will be affected in some way. Usually they come out feeling very tired.

While there is a lot of effort currently directed toward elimination of noise and vibration in the cabin of an aircraft (soundproofing materials and new structural techniques, for instance), the average city worker is seldom protected from the same, though lesser, stimuli. If we are to learn anything from jet crew fatigue, it might be this: Accoustical ceiling tiles, carpeting and similar sound proofing measures may go a long way toward minimizing or eliminating midday letdown.

Visual problems are another culprit in the crime of fatigue. The jet pilot is exposed to many visual difficulties associated with his work and surroundings. The glare at altitudes of 35,000 feet, for instance, comes from below the plane rather than above. The shape of the human face is not designed to protect against this phenomenon (whereas the forehead, eyebrows and eye sockets will help to cut down on glare coming from above). As a result, the pilot develops what is called a "haziness vision"—making it very difficult to perceive objects or read cabin instruments. And the more he tries to adjust to these conditions, the greater the fatigue.

Poor lighting

While groundlings do not have to worry about solar glare, poor lighting conditions or glare coming off the hood of an automobile can produce very much the same effect. One researcher writes: "Unmistakable bad conditions of lighting and 'forced labor' of the eyes . . . induce fatigue prematurely in persons who have no optical or neuromuscular defect. By 'prematurely' is meant sooner than it occurs as part of the

general fatigue of the system. . . ."

The "forced labor" factor referred to is excessive use of the eyes. A pilot, of course, is constantly scanning the skies, checking instruments and watching the visible areas of his plane. This is part of his job and can't be avoided. The average worker, however, can minimize "forced labor" by a bit of concentration. The daily commuter who prefers to window gaze on his trip into the city, for example, may be setting the stage for a fatigue level far greater than those reached by his dozing or newspaper reading colleagues.

Fatigue factor

A rather surprising fatigue-causing factor turned up by recent studies is cigarette smoking. While cigarettes have been implicated in many other problems, this conclusion resulted from investigations involving hypoxia—or oxygen starvation. At altitudes over 5,000 feet, it was found, less oxygen is diffused into the blood simply because pressure levels are lowered. After a while, this causes the impairment of certain mental and physical processes. Generally speaking, though, the crews and passengers of commercial aircraft are seldom exposed to this condition long enough to cause any serious problems.

Smoking enters the picture through the fact that it further reduces the capacity of our lungs to diffuse oxygen into the bloodstream. When an oxygen deficiency of this sort develops, lactic acid (present in muscular fatigue) builds up. At the same time, the muscle continues to work. The result at high altitudes: faster onset of fatigue symptoms. The result at ground level: possibly the same thing.

Effect of smoking

In short, smoking "clogs up" the alveolar spaces in our lungs and thus reduces the ability to intake oxygen. In a jet this lack of oxygen may actually cause a person's body altitude to be over 10,000 feet—even though the cabin is pressurized to 5,000 feet. Therefore, there is a concerted effort on today by the airlines and various agencies associated with them to cut down or eliminate the smoking habit among jet crew members.

Temperature and humidity are still other factors in jet crew fatigue. Both may be extremely high in the cabin of a plane at take-off time—yet, within minutes, they drop to levels which may be below the norm. This rapid change often has an extremely fatiguing effect on pilot and crew.

Similar temperature and humidity variations can take place in the summertime among office workers. Sudden and frequent movement in and out of air-conditioned places on a particularly uncomfortable day can literally drain a man's energy in minutes. Thus, when trying to eliminate that midday letdown, it might be well to consider a more stable

temperature and humidity atmosphere—or at least minimize sudden changes.

Richard H. Beck, Chairman of the TWA Air Safety Committee, says in *The Airline Pilot*, "The human body is . . . an extremely flexible organism. It has tremendous powers of adaptability and can withstand . . . physical, mental, and psychological punishment. [But] if it is subjected to too many adverse factors at once, or to an 'X' number of adverse factors over an 'X' period of time, it is quite probable that it will break down. . . ."

Very often this breakdown takes the form of utter fatigue. Sometimes this is of the "acute" variety, resulting from normal everyday pressures, and will disappear with adequate rest or diversion. Other times, though, it is "chronic," as in the case of many airline pilots, and requires more consideration.

When chronic fatigue occurs, usually much more than noise, vibration, visual problems and other physical effects are involved. The workload of the individual must be looked into; his personal and family problems should be investigated; and his work performance should be watched carefully. All these factors —plus those we've mentioned— may be contributing to the overall fatigue problem.

Getting unduly tired is not an unusual symptom. Very often it can be prevented by some simple steps. But if cutting down on noise and improving lighting conditions in your office doesn't help, why not try getting into bed an hour earlier for the next couple of nights. You'd be surprised at what that can do.

BRAM

"Here's where we are now."

KFS

Shaping glass bubbles can become a complex skill as it is for this expert in laboratory apparatus.

QUIZ

Glass that almost isn't

by John and Molly Daugherty

SCIENCE is developing surprising new properties in glass. You can squeeze a glass coil, release it, and see it spring back into shape. Glass can now be elastic.

With a piece of glass piping you can drive a nail into a block of wood. Specially-strengthened glass can take all the pressure you alone can give it. It'll take lots more—as much as 400,000 pounds a square inch.

Not all glass sinks in water. Foamglas is a cellular glass that floats. It can be cut with regular tools.

Try this quiz to find out what else you know about glass.

1. **The method that shows the greatest promise in strengthening glass to withstand tremendous pressure is**
   a. **Chemical tempering**
   b. **The increasing of glass density**
   c. **Physical tempering**
2. **Glass is so transparent that about 40,000 people try to walk through it every year. The danger is lessened with**
   a. **Tempered plate glass**
   b. **Laminated glass**
   c. **Annealed plate glass**
3. **The green of common bottle glass comes from oxides of**
   a. **Manganese**
   b. **Iron**
   c. **Copper with cobalt**

4. Of these three general types of glass, the one manufactured in the greatest amounts is
   a. Lead
   b. Lime
   c. Borosilicate
5. Archaeologists believe glass was made before 3,000 B.C. The era that revolutionized glass-making was
   a. The period from about 300 to 20 B.C. in Phoenicia
   b. The golden Age of Rome
   c. The rise of Venice after the fall of Rome
6. Transparent glass is a
   a. Crystalline solid, like a clear ice-cube
   b. Hard solid, like the metal iron but transparent
   c. Non-crystalline solid without a fixed melting point
7. The type of glass widely used in TV and neon-sign tubes is
   a. Soda-lime
   b. Lead
   c. Borosilicate
8. The list of formulas for making glass variations from the several basic types to obtain specific properties has grown to approximately
   a. 1,000
   b. 35,000
   c. 70,000
9. Of the following descriptions of the thermal properties of glass, the one that is *true* is that glass is a
   a. Poor absorber of heat
   b. Poor radiator of heat
   c. Poor conductor of heat
10. Glass formed by natural forces occurs in many parts of the world. Strange glass trees (a form of glass called *fulgurite*) are found in
   a. Uruguay
   b. China
   c. Iceland

Answers:

1—a Chemical tempering. Some aspects of chemical-tempering processes date back over 70 years. But new chemical-tempering processes change the surface layer chemically after it is formed so that it differs chemically from the interior glass. Atoms of other elements replace some atoms of the glass surface. This replacement strengthens the glass to withstand stresses three times greater than glass can withstand when physically tempered by controlled heating and cooling.

Unique features of chemically-tempered glass are that the thickness of the glass doesn't affect its strength and continual flexing doesn't weaken it.

2—a Tempered plate glass. It looks like ordinary plate glass but is many times stronger. It is made by reheating plate glass and rapidly cooling the surface by air jets. This glass is stronger and bends considerably without breaking. But if it does break, it breaks all at once into chunks like rock salt. It doesn't shatter into slivers as ordinary glass does.

3—b Iron. Small amounts of metal oxides color glass. Chromium colors it a rich green. Copper with cobalt colors it blue; and manganese, pink to violet. Colloidal gold colors it ruby red; and calcium fluoride, translucent white. Excess amounts of metal oxides produce different colors.

4—b Lime. Lime glass is a soda-lime-silica glass. The amount of lime glass at times reaches 90 percent of all glass production.

Ancient glassmakers found that they had to add lime (Ca0) to mix of silica ($Si0_2$) and soda ash (Na_2-

CO_3) to make glass. Without the lime, waterglass, a thick syrupy liquid soluble in water, was formed.

5—a The period from about 300 to 20 B.C. in Phoenicia. As far as we know, the Phoenicians discovered that glass can be blown as a soap bubble. This revolutionary technique paved the way for mass production of glass. The first golden age of glassmaking centered in Rome. Venetian glassmakers created the second in Venice.

6—c Non-crystalline solid, sometimes referred to as an amorphous or a vitreous solid. As molten glass solidifies, it retains the properties which in other inorganic solids are found only in the liquid state.

Molten iron and water become crystalline when cooled to the solid state. They do so at a fixed temperature with no temperature change during the change in state.

When heated, glass becomes molten gradually over a wide temperature range, which makes it easy to handle and form into various shapes during processing.

In crystalline solids there is an orderly arrangement of atoms and molecules in characteristic patterns.

7—b Lead. Lead glass resists electricity. It works easily, and its lustrous sparkle makes it ideal for fine crystal glassware, too. Lead glass is made by using lead oxide (litharge) instead of lime in the soda-lime-silica formula of common glass. Lead glass is also called flint glass because originally the silica component of the glass mix came from ground flint.

8—c Approximately 70,000. Silica (sand) is the principal ingredient in glass. In lime glass the silica accounts for about 71 to 78 percent of the glass. In special re-treated borosilicate glass, called silica glass, the silica content is increased to 96 percent. Silica glass may be heated red-hot and plunged into ice water without breaking.

9—c Glass is a poor conductor of heat. This property is offset by the fact that it is an excellent absorber of heat. Glass absorbs about 90 percent of the radiant heat that falls upon it. And good absorbers are good radiators of heat. Glass oven dishes are excellent for baking food.

10—a Uruguay. These tree-like natural glass formations occurred long ago when lightning struck sand dunes along a beach. The intense heat from the lightning fused the sand into glass with many slender tubes of glass extending to great depths. As the winds blew away the remaining sand, the crystal formations were exposed. They appeared as a shining forest.

Volcanic action produces a natural glass, obsidian, which was used by early man for tools and weapons.

Score Yourself:

9—10 right—Your brilliance is as clear as crystal.

4— 8 right—Your average knowledge is transparent.

0— 3 right—Your score lacks luster.

THE HUGH DOWNS COLUMN

Is man better than computers?

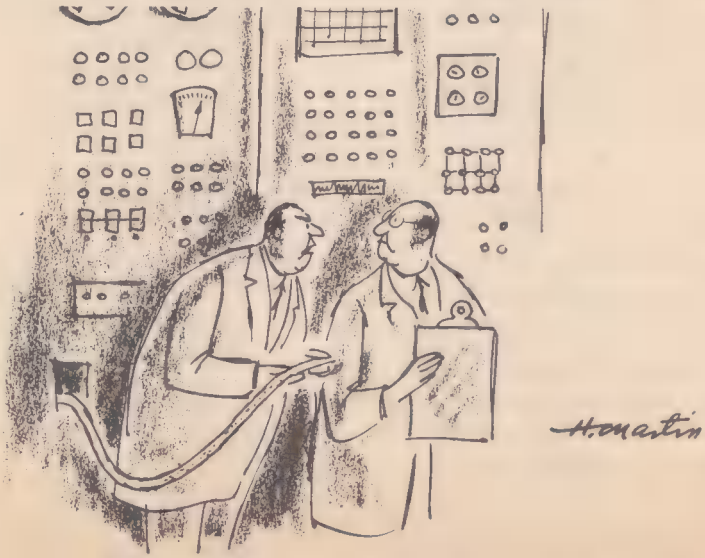
A LOT of the arguing about whether or not machines can think seems to me to miss the main point of the problem.

On the one hand almost all the practical scientists and technicians who build, program, and service the machines dismiss any suggestion that they "think" as mystical nonsense. Admittedly there is mystical nonsense in a good deal of the arguing on the side of thought for the machines.

But I notice some of the statements against machines' thinking have a flavor of anthropo-centrism. It seems desperately important to some proponents of the view that machines will never think, to make it a case for the sanctity of the human spirit by drawing an anxious and biased line between the human brain and all advanced thinking machines now built or conceivably designed. Usually this argument apologizes for possible semantic obstacles at the outset and then promptly takes refuge in a fortress of semantic boulders.

Sometimes, though, a scholar through technical knowledge and writing skill successfully avoids confusion of word-meanings. Such a man is Edward T. D. Calhoun of Bell Telephone Laboratories, who mounts a very clear case in his "Why Machines Will Never Think," a chapter of the book, *Automation—Implications for the Future* (Vintage Books, 1962) but whose very clarity illumines the fallacy of his conclusion.

"I certainly could do without these smart alecky answers."



He successfully proves that a human mind will never know or be able to prove that a complex machine is thinking, but only in the same way that my human mind will never know or be able to prove that your mind is thinking. What emerges, is rather, a strong argument for the solipsist view, in which a conscious entity can hold the belief that his is the only consciousness, and that similar as others are in appearance and behavior, they are nothing more than props in a universe created within his own mind. The solipsist view is unanswerable. I would love to attend a solipsist convention.

Now it is much easier due to dissimilar appearance and behavior to deny consciousness to a machine, however complex it may be.

Calhoun, step by step, and with truly admirable clarity, takes us through the transistion from primitive magic to physical laws to the "indefinable promise of Automation." And quite candidly, he says, "Although we fail to understand ourselves as persons in a nonpersonal world, we may yet describe ourselves as nonpersons in a nonpersonal world." In spite of what is widely felt, this is by no means a catastrophe.

He says, "Do computers think? When I find my way home for the hundredth time, I do it automatically. If anyone asked me what I meant by finding my way home automatically I should answer that I did it without thinking, because it was such a habit."

What Mr. Calhoun is talking about here is feeling. Of course many human (as well as machine) thought processes are unconscious, in that they do not require attention. Attention is the focused light of consciousness upon an event, condition, problem or other element. The question of whether a very complex machine has this quality of consciousness is not one I would attempt to prove or disprove. It is hardly debatable, though, that operative machines now perform maneuvers appearing to require attention.

Follow programs

It is frequently said that computers do only what you program them to do. Certainly this is true. But they can be programmed to behave adaptively, they can be programmed to improve their own programming, they can be programmed to learn, they can be programmed to program themselves and they can be programmed to attend. All of these characteristics are "programmed" into humans. In our case, giving attention is linked to consciousness (the solipsist view would be that I know this to be true only in my own case). Now whether giving attention involves what can be called consciousness in any large machine I do not know. I only believe there is no scientifically or logically demonstrable proof that the idea of consciousness must necessarily be excluded from a complex set of relations, operations,

Machines are destined to become more capable, more lifelike.

functions and processes, embodied in a giant computer and termed "non-living" by our ground rules; and that most arguments requiring such exclusion are due to fright brought on by misquided anthropocentrism.

In the same book, *Automation—Implications for the Future,* Herbert A. Simon writes: "We can dismiss the notion that computer programmers will become a powerful elite in the automated corporation. It is far more likely that the programming occupation will become extinct (through the further development of self-programming techniques) than that it will become all-powerful. More and more, computers will program themselves; and direction will be given to computers through the mediation of compiling systems that will be completely neutral so far as content of the decision rules is concerned. Moreover, the task of communicating with computers will become less and less technical as computers come—by means of compiling techniques—closer and closer to handling the irregularities of neutral language."

In other words, the machines are destined to become not only more capable but more lifelike. Both the neutrality of compiling systems and the increasing random element in goal-installation means the machine will more and more determine (even seek) its own goals. Moreover, we must as humans more and more face up to the nature of goals built into us in dealing with our identity in the cosmos (goals, for example, such as self-preservation). As machines become more lifelike we cannot help seeing more of our mental activity and some of our emotional activity in a machine-like light.

Machines is a very poor word. So is computers. What is meant of course is "cybernetic contrivances," with the implication of levels of organization of an order comparable at least to the mental activity of living organisms.

Identity crisis

Simon writes: "It is only one step from the problem of goals to what psychiatrists now refer to as the identity crisis, and what used to be called cosmology. The developing capacity of computers to simulate man—and thus both to serve as his substitute and to provide a theory of human mental functions—will change man's conception of his own identity as a species."

Man has always sought proof that the universe regarded him as "special." His cosmologies, his religions, his self-descriptions have had in common that man is in some way unique. This need has survived a series of shocks: the discovery that the universe is not necessarily

made to serve man; that his world is not located at the center of this universe; that he is not the only creature with thought and feeling; that machines can duplicate his thought processes.

We are physically composed of chemicals whose elements are "inorganic," in other words, matter indifferently transformable to lifeless substance or to organic tissue; we are animal, in the same sense that a gorilla or a rhinoceros is an animal.

Man is in the position of a child confronted with a raft of brothers and sisters. With maturity he can hopefully abandon his need to be favorite.

If we are to realize our worth we must through a series of painful steps, get over any idea of "specialness" of self, family (or clan or tribe), religion, community, state (or nation or alliance bloc), race, species, genus or phylum. We must even overcome the idea that life must remain somehow a fire of the gods, taboo, and not to be stolen by Promethean Science or created by arrogant humans. If we can create with our minds and hands sentient beings, organic or mechanico-electronic, or can create machines which can program other machines which can build such sentient entities complete with desire to stay alive and to reproduce themselves, we will have merely done with understanding what we do in procreating without understanding. Thus will we affirm our participation in divinity. While a moral obligation will attach to such an achievement, if there is a moral wrong, then there was a moral wrong in inventing the airplane and, as the fundamentalist said, "If God had wanted us to fly, he'd have given us wings." One might say, "If God had not wanted us to think he'd have not given us a brain."

How far complicity?

Not being a solipsist, I do not believe I am the only thinking being in the universe. I believe there are other humans who think and feel more than I do. I believe the so-called lower animals feel and give attention almost the same as I; that they also think, but not as well as I; that there are machines operating right now that think better than I in certain ways but probably have no feeling, yet that we are on the verge of something new. Consider: There may very well one day be built a complex of machines programming themselves, even directing some of their own design, adapting swiftly to irregularities of environment, swallowing staggering quantities of information, moving to conform to the limitations of their human co-workers through heuristic programming multiplying levels of organization and developing a super-consciousness beside which human sentience is as a crustacean's. Even though the idea is debatable (and to some, fearful), it cannot be dismissed by arguments based on inflexible ideas of the uniqueness of man.

PLEASE EXPLAIN

NASA

"Gulliver," a radioisotope biochemical probe, contains a broth of medium in which almost any form of bacteria will grow in the search for life on other planets.

Life on earth and elsewhere

How do scientists now feel about the possibility of life of some form evolving on other worlds?

At the last meeting of the American Association for the Advancement of Science, Dr. Harold C. Urey of the University of California discussed some of the problems of the origin of life on earth and elsewhere.

He noted that life is dependent on the chemistry of carbon and the other elements with which it forms characteristic compounds.

"It is probable," Dr. Urey stated, "that carbon compounds of considerable complexity are present wherever carbon and other elements are present in the universe outside the regions of high temperatures in the stars, that is, in interstellar space, interplanetary space, in the atmospheres of the large planets, on the surfaces of the smaller planets, etc. . . .

"But living organisms as we know them exist only in water solution and their entire life processes take place in this medium. Living things exist at mild temperatures and the chemical reactions are exceedingly

sophisticated and take place at mild temperatures. Liquid water is a necessity for the origin of living things as we know them. This means that life could only originate on the surface of a planet such as the earth or Mars or possibly the moon."

Dr. Urey went on to explain that a steady source of free energy such as that given off by the sun, is also necessary for the beginning of life. This is needed to "promote an extensive chemical reaction so that the chemical experimentation required to establish metabolism and the replicative system could take place continuously." He noted that science has taken "exceedingly small initial steps" along the road to creating the simplest living organism in the laboratory.

"It is probable that many experiments must be done before it will be possible to see that very narrow, but I think feasible, path by which life evolved. Many people ask the question of how long did it take for life to evolve. I think those who have made the most extensive study of the very complicated chemistry of living organisms are those who are most amazed that life could ever have evolved at all. But in coming to this emotional conclusion, I think there are features of the natural processes that we do not appreciate. We are accustomed to chemical reactions that take place in our laboratories in short periods of time. We have no concept as to what can happen in a million years. We have no concept as to how large an ocean is and what an enormous amount of experimentation can take place in a large body of water over long periods of time.

"It seems to me that it may be that life originated even during the time before one could definitely say that the accumulation of the earth was complete. . . . Thus recent reports of the residue of living things found in [extremely ancient] rocks or even in [much older] meteorites do not appear impossible or unreasonable."—*D. C.*

Everyone's talking about fuel cells. How do they work? What's their advantage in generating electricity over other systems, new and old?

A fuel cell is a device for generating electricity, and, to understand its value, let's consider the word "fuel" and "cell" separately.

To generate electricity from a fuel such as coal or oil, that coal or oil must first be burned. The energy of its burning heats water to steam which is used, in turn, to rotate a turbine through a magnetic field. That produces an electric current. In other words, we are converting the chemical energy of the fuel into heat energy and then converting the heat energy into electrical energy.

In the course of this double con-

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version, much of the original chemical energy is wasted. However, fuel is so cheap that even this waste doesn't prevent us from being able to produce large quantities of electricity without unusual expense.

It is also possible to convert chemical energy into electrical energy directly, without going through heat. To do so, we must make use of an electric cell. Such a cell consists of one or more solutions of chemicals into which two metal rods called electrodes are dipped. A particular chemical reaction goes on at each electrode and electrons are either released or absorbed. The electron pressure at one electrode is higher than at the other, so that if the two electrodes are connected by a wire, electrons will flow through that wire from one electrode to the other.

Such an electron flow is an electric current, and that current will continue as long as the chemical reactions proceed in the cell. The flashlight battery is an example of such a cell.

In some cases, if an electric current is forced back through a cell after it has run down, the chemical reactions within it are made to run in reverse, so that the cell can then store chemical energy and be used to produce an electric current again. The storage battery in an automobile is an example of such a reversible cell.

Much less chemical energy is wasted in a cell, since it is there converted into electricity in a single step. However, the chemicals used in cells are all pretty expensive. Zinc goes into the making of a flashlight battery, for instance, and lead into the making of an automobile storage battery. If you tried to use enough of these metals, or similar ones, to prepare electricity for a whole city, it would cost billions of dollars a day.

A fuel cell would be a device in which the notions of fuel and the electric cell are combined. It is a cell in which the chemical reactions involve not expensive metals, but cheap fuels. The chemical energy of those fuels become electrical energy in a single step, with much less loss than in the usual two-step fashion. The amount of electricity available to mankind can then be greatly multiplied.

The catch is that it is difficult to prepare a fuel cell that will really work in a reliable fashion. Cells have been prepared in which electrical energy is drawn from the combination of hydrogen and oxygen, but hydrogen is still fairly expensive. Carbon monoxide has been used in place of hydrogen and it is somewhat cheaper. More recently, cells have been prepared that involve the combination of sewage and oxygen under the influence of bacterial action. Surely the thought of turning sewage into electricity is exciting and would solve two problems, cheap power and disposal of garbage.

Much remains to be done before fuel cells are really practical, but they represent one of the bright hopes of the future.—*Isaac Asimov*

LETTERS TO SCIENCE DIGEST

Honor among snakes

I enjoyed the "Animal Behavior Quiz" (Nov. '65), but I have doubts about some of the statements in it. As for rattlers fighting one another by the Marquis of Queensbury rules, I suspect, that the rattlers described were just horsin' around and the reason for killing just hadn't crossed their minds yet, or like as not it would have happened.

As for chickens, their being domesticated doesn't do much to separate them from the ways of other birds. Deprive your chickens of protein, and the first one to show blood may be taken apart and devoured by the others. Toss a strange rooster into a flock and watch the fun.

The procedure in all cases seems to be stand off, back off, or fight, or any combination of the three. I don't know what name can be given to the sum of this behavior, but I doubt if Marquis of Queensbury rules is the proper answer.

MAYNARD M. PIERCE
St. Louis, Mo.

Fascinating

Your Jan. '66 issue was, to say the least, fascinating. It covered so many interesting topics that it leaves me frustrated that I don't know more about each. Please keep frustrating me!

STEVE B. SAFRAN
Englewood, N.J.

Spread of A-weapons

President Johnson has recently said that "to halt the spread of nuclear weapons is the most important task on earth."

I believe that your magazine could render a valuable service with an article on the subject.

H. DE VRIES
New York, N.Y.

Science Digest *carried a report on nuclear proliferation in Aug. 1965 and it reports on new developments as they occur.—Ed.*

Ancestors or descendants

In the small item, "Sea Colonies," in your November issue, an ocean-bottom explorer is quoted as predicting: "Our ancestors will stay in the depths even longer than we did." He should, of course, have used the word "descendants" instead of "ancestors."

ALLEN GLASSER
Brooklyn, N.Y.

He did; the error is ours.—Ed.

Cheap at the price

Quite by accident, I discovered *Science Digest* some months ago. Thereafter I became a subscriber and I save each copy. I wish to place on record my appreciation in having your "Science News Monthly."

Such a small-sized book—but what contents! It is cheap even at the British price.

L. ROTINGOI
Halifax, Yorkshire
England

Blackout

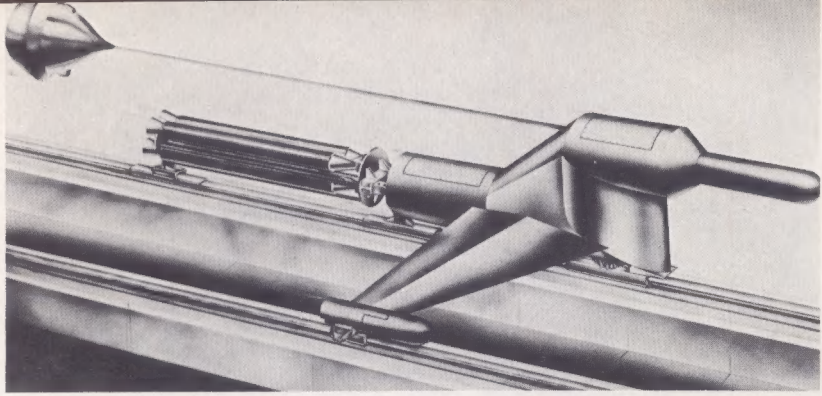
The explanation of the Northeast power blackout in "Late Science News" (Jan. '66) is unscientific and misleading.

When a generating plant cuts itself off from a network, the load—not the power—is transferred to the other stations—not other lines. Unneeded or extra power does not "surge in" or "rush in to fill a vacuum." Every lamp, motor or other device connected to a power system would take all the current the system could supply if it were not for the inherent resistance or counter-pressure in the device. So generators and lines of limited capacity are provided with automatic equipment to cut off the connection when the load gets too heavy—not too light.

If four men are carrying a big rock and one of them has to let go and the other three can't carry it between them, what happens?

EDWARD N. HORR
Hickory, N.C.

The Sir Adam Beck power plant in Ontario, where the blackout began, was connected both to Canada and to the United States. When its connections to Canada were broken, almost all its power output went to the United States. As a result, the first failures in the United States were from generators overspeeding and getting out of step. Subsequent failures were from overload as stations to the east tried to assume the extra burden. For a full explanation of what happened to our international power grid on November 9, 1965, see "What the Blackout Taught Us" (Feb. '66).—Ed.



Artist's concept shows the rocket-powered supersonic sled being slowed by its balloon parachute during its run down a seven-mile rail course at Holloman A. F. Base, N. M.

2,300-mph sled

With the anti-missile missile moving ever closer to reality, engineers are trying to determine what effects a nuclear armed anti-missile missile might have on a conventional missile.

The Goodyear Aerospace Corporation has built a highly sophisticated, rocket-powered supersonic sled designed to test the results of such an encounter. The sled carries a missile nose cone through a simulated atomic blast area at 2,300 mph or about three times the speed of sound.

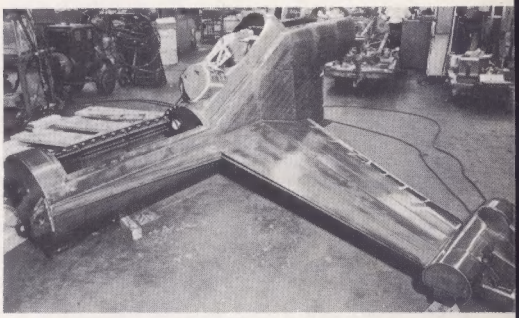
The nose cone is mounted on the forward end of the sled. Blast data recording equipment is housed in the forward and rear centerbody compartments, as well as in a container at the end of the outrigger, which will also house a high speed camera.

A ballute, or balloon parachute, used to decelerate the sled after it passes through the blast area, is housed in the centerbody midsection.

The sled is being tested at the Air Force Missile Development Center at Holloman Air Force Base, N.M. The 4,500-lb. sled rides on a track that is nearly seven miles long. The high energy blast hits it when it is approximately 13,000 feet down the 35,000-foot-long rail course. At that time, the sled encounters temperatures of about 500° F.

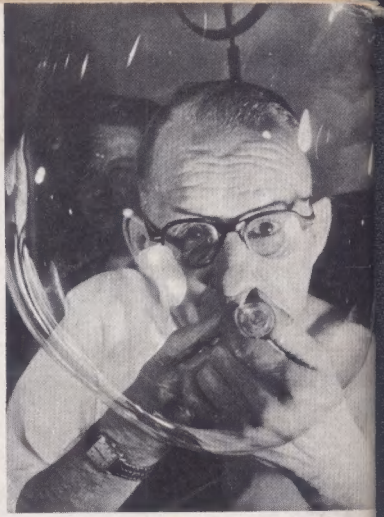
The sled is made from a new ultra-high-strength alloy steel called HP 9-4-25, developed by the Special Metals Division of Republic Steel. The steel was designed originally for highly stressed, solid-fuel rocket-motor cases.

Steel sled awaits shipment to Air Force from Goodyear Aerospace, Akron, Ohio.



In this issue . . .

The cause of science is served not only in the laboratory. Here a swimming pool is the scene of Illinois Institute of Technology research in the performance of an oceanographic submarine. The full story of IIT is told starting on page 48.



The bubble the man is blowing is a glass one. What do you know about some of the astounding qualities of glass? Attempt the quiz on page 89.

One of the great science personalities of our time is William Pickering, director of the Jet Propulsion Laboratory in Pasadena, Calif., the strangely named nerve center of our lunar soft-landing undertaking. For his story, turn to p. 12.

When Gulliver travels, it'll go millions of miles to the planet Mars to check on the possibility of life there. (Life-detection devices will be shot out of the vehicle to test the "soil.") For a report on extra-terrestrial life, see page 92.

The "thread" being wound on a spool in this photo is made of a revolutionary new material second only to diamonds in hardness. See page 75.

His name became a legend in the history of the sea a few years ago. Now he is our Inventor of the Month. See p. 23.